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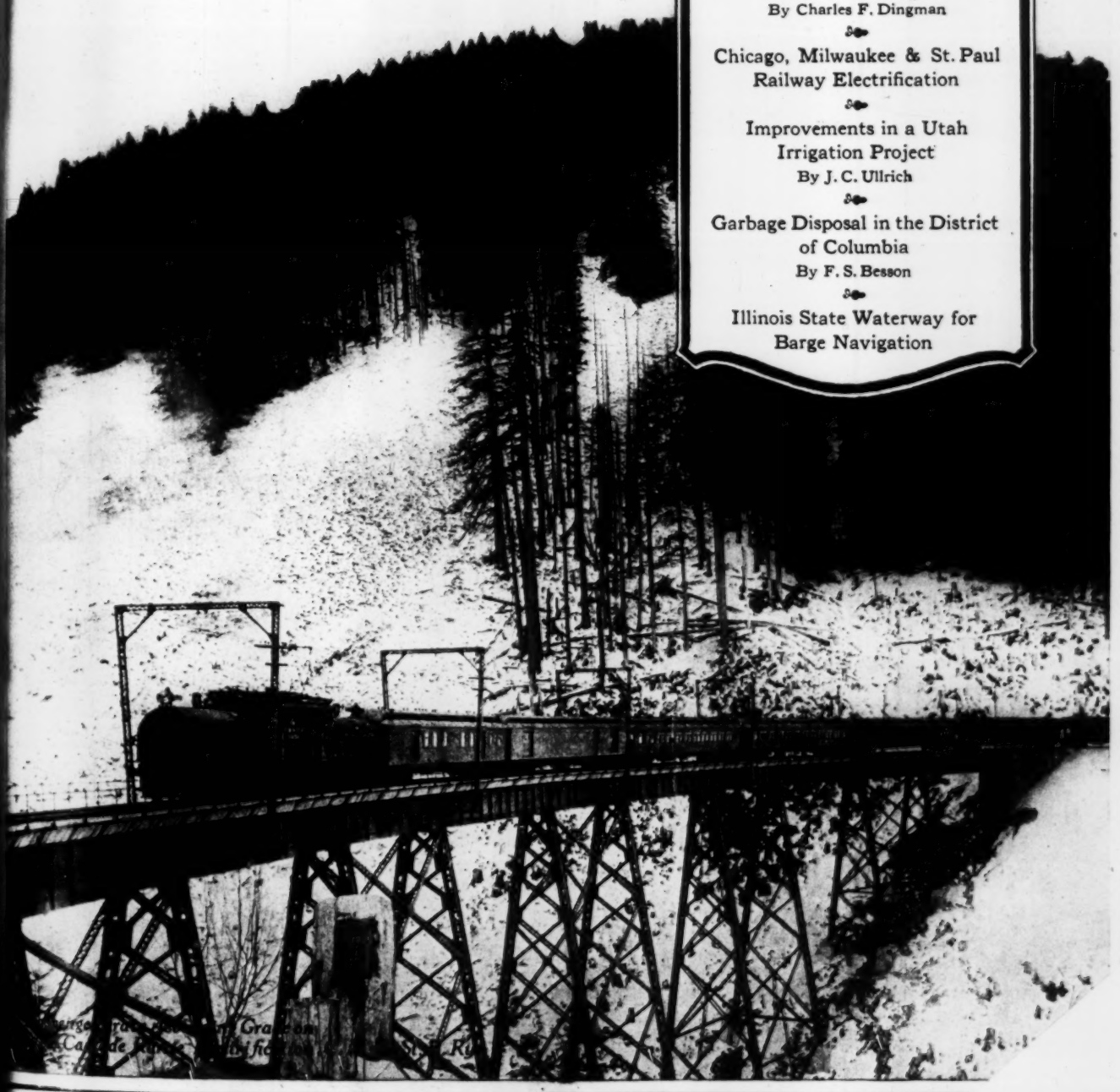

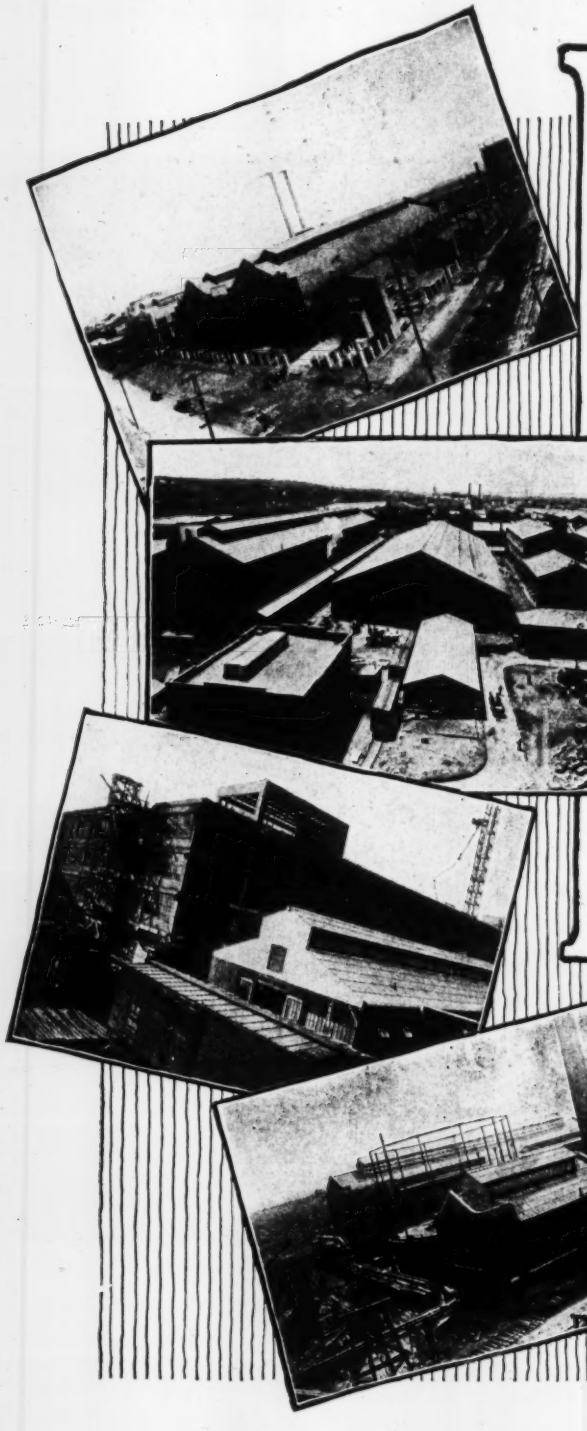

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

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Annihilating Space

FROM Cleveland, Ohio, to Mineola, L. I., a distance of 423 miles, in exactly three hours time, the record-breaking trip of a mail airplane on Nov. 19, is a fresh reminder of how space is being annihilated and the world made kin by the persistent efforts of the engineer in the field of transportation.

Commendable Water Saving

NOTWITHSTANDING a large increase in population the total pumpage at the Buffalo water-works on a recent day was two million gallons under the lowest previous record for some twenty years—thanks to waste preventive work. The actual figures were 97,340,000 on Nov. 14 last and 99,311,000 on Nov. 21, 1909. Compared with 1916, the saving of coal is nearly 1,500 tons a month. This is a commendable record. Philadelphia might well take note of it.

Highway Research

THOUGH a most important step has been taken, through the recent organization of the Advisory Board on Highway Research (see *Engineering News-Record*, Nov. 18, p. 1010) toward the accumulation, co-ordination and dissemination of problems relating to highway construction and economics, so many of which are yet indeterminate, too much stress cannot be laid upon the need that exists for getting under way. The time element is very important. The sooner the board begins to function, and the sooner it begins to publish the results of its research, the greater the benefit to highway organizations and the less the loss due to expenditures on unsound designs and methods. If the advisory board is to be of maximum value its permanent organization should be effected as soon as possible, and research be put under way with all reasonable speed.

French Reconstruction

FRENCH reconstruction, it is shown by official figures as of Oct. 1, 1920, continues at the high rate recorded previously in this journal. Of the 4,241 factories damaged or destroyed, 3,239, or 76 per cent, are again in operation, employing, however, only half as many men as they did before the war. Progress has been equally rapid in practically all industries, only food-product plants being notably below the average in percentage of rehabilitation. Agriculturally, too, the progress continues to be excellent. Probably less than 4 per cent of the churned-up land will be in crop next spring. The country's financial condition is not so encouraging, but the revenues have increased very largely. Add to these evidences of progress the swing away from radicalism on the part of French labor, and we get a hopeful industrial picture. If all other continental countries were doing as well, there would be no cause for the present legitimate discouragement over European industrial conditions.

A Common Misconception

CONDEMNATION proceedings to attain municipal ownership of water-works and other public utilities is frequently advocated. The Federal District Court at Fargo, N. D., has just ruled that the City of Bismarck has no authority to acquire the property of the Bismarck Water Supply Co. by that means. It might save other cities delay and expense to know that there are few if any cases on record of municipal acquisition of any privately-owned utility under a city's general authority to take private property for public use by condemnation.

The World's Debts

HUGE INDEBTEDNESS, it is generally known, has been one of the war's aftermath's, but it is not so widely appreciated that the indebtedness has continued to increase at a tremendous rate in the two years since the signing of the Armistice. Figures on the subject have just been compiled and published by O. P. Austin, of the National City Bank, New York. The world's national debts, which totaled 43 billion dollars in 1913, had increased to 212 billions at the close of the war. One year later the figure was 256 billions and in November, 1920, 300 billions. In other words, many governments are running on credit; their expenditures still exceed their receipts. In fact three-fourths of the governments of the world are showing budget deficits. Not only has the bonded indebtedness gone up, but the total of outstanding paper currency has increased. The figures are: 1913, 7½ billion dollars; at the Armistice, 43 billions; November, 1919, 55 billions; November, 1920, 82 billions. The ratio of gold to currency has, in the same period, dwindled from 66.3 per cent to 9.2 per cent. All money figures are computed at pre-war currency values, but all obligations and currencies of the Russian Soviet government are excluded. It is obvious that this condition of affairs increases the difficulties of commercial rehabilitation. Strenuous efforts are being made in most of the countries to balance budgets —a movement given emphasis at the recent Brussels financial conference of the League of Nations. To us the condition has a very practical interest, since the depreciated currencies are a handicap to our export trade. We shall have to finance Europe on a large scale to stimulate the export trade we are capable of supplying.

Industrial Standardization

IT IS INTERESTING to find that a recent discussion of standardization of motor car parts in our London contemporary, *Engineering*, makes the point that such standardization "is a trade matter rather than one for the British Engineering Standards Association." The statement is particularly significant because made in England, where very little industrial joint action to establish commercial standards of shape and size has

been possible, and where, on the other hand, centrally controlled standardization has been in active progress for nearly twenty years. The slowness of industrial self-standardization, in fact, was a main motive for the organization of the Engineering Standards Committee, now transformed into an association. Even today this trade standardization is so difficult and slow, over there, that our contemporary says, with a hopelessness rather out of harmony with the facts, "We do not know if this country will ever attain to it. It is possibly of too radical character to be accepted by our motor firms." That in spite of this statement the journal urges the motor trade to enter on the undertaking suggests that the association's work, in spite of its great scope, does not do away with the need for other standardization by the industries themselves. Many conditions existing in our own country support this conclusion. In fact, engineering and industrial standardization may exist side by side to mutual advantage, and possibly they have distinct fields of service, as the English writer assumes. If this latter be the case, a conscious delimiting of these fields would be eminently desirable. It would place upon each set of interests a definite responsibility for results within the limits marked out. Today there is no such clearly placed responsibility.

No General Code

CODES OF ETHICS are before the profession in a definite way because of the proposal of the chairman of the code committee of the American Society of Mechanical Engineers that there be a universal code for all engineers and architects. We do not believe that careful consideration will win support for this proposal among civil engineers. The feeling is widespread, and correct, that the point of view regarding professional standards differs essentially between the electrical and mechanical engineers on the one hand, and civil enginers on the other. It is inevitable that it should be so. The admixture of manufacturers and salesmen among the electrical and mechanical engineers, and the employment in technical capacities of so many of these engineers themselves by manufacturing enterprises, where the exigencies of selling the product are so constantly forced on them, produces in their circles a commercial atmosphere quite at variance with strict professional views. The feeling that there is a fundamental difference in point of view is becoming more, rather than less, emphasized and was one of the principal reasons for opposition to the civil engineers' entry into the federation. We need a code and we need enforcement, but results that the civil engineers should seek are not to be obtained through cooperative efforts.

Arkansas Road Boom

ONE OF THE PURPOSES of the Federal-aid highway acts has been to so strengthen highway administration in each state that road work may proceed along sound economic, engineering and administrative lines. The influence of the highway department, it was thought, would go beyond the Federal-aid roads themselves; the example was expected to be beneficial to every road building agency in the state. How much a strong influence is needed is shown in the example of Arkansas, whose highway situation is reviewed on page 1099. In a few years its projected highway expenditures have jumped from an exceedingly small figure to $56,000,000. The state highway department, save for Federal-aid projects, is powerless. All roads are built under specially organized road districts. The engineers are consultants, hired by commissioners who have little appreciation of engineering service, highway practice or wise handling of large sums of money. The results are just what one could have predicted—wild financing, bad highway practice, incompetent engineering. To date there must be much condemnation; praise only for the desire the Arkansas people show for wanting to get out of the mud. Evidently, though, as it appears from our article, there is an awakening. Some good work, it appears, has been and is being done. The need is felt for wiser expenditure and for close supervision by a competent authority. The latter, close supervision, can be attained without large state expenditures. Iowa did it very successfully. Arkansas may well follow her example. A continuance of the present course can only result in very heavy losses to the people of the state. The present depression, very severe in some parts of Arkansas, will help to bring about saner conditions.

Engineering Service Discredited

AS ONE of its eleventh-hour acts last month the Board of Estimate and Apportionment of New York City, in its revision of the municipal budget for the new fiscal year, lopped $3,000 from the salary of its chief engineer, the cut was from $12,000 to $9,000 a year. No justification for such a reduction exists, as the post is one demanding not only high technical qualifications but also sound business judgment, a thorough knowledge of municipal engineering and finance in all of their ramifications and a character capable of resisting political pressure brought to secure approval of public improvements of doubtful economic value. The action of the Board of Estimate, however, has a far wider significance than the mere reduction of the salary of a city employee. It can be interpreted only as open disparagement by the administration of the value of technical advice in matters involving the expenditure of millions. The board's action deserves to be condemned particularly at the present time when the salaries of professional men have lagged far behind the rising scale of living costs and, instead of reductions, merit substantial advances to maintain them on the same relative plane of compensation as existed prior to the war. The post of chief engineer of the Board of Estimate and Apportionment demands the best there is in the way of technical and administrative skill and has been ably filled for many years by Nelson P. Lewis, who retires from the city's service, at his own request, this month. If the Board's action was taken on the grounds of "economy" it has shot wide of the mark. Quibbling over a paltry few thousand—which are insignificant in the aggregate of the city's budget but which mean much to the incumbent of the office of chief engineer—the Board of Estimate has failed to appreciate the broader aspects of the problem, namely, that the proper kind of engineering advice demands adequate compensation and will save the city many times the salary of the chief engineer and his entire staff. It cannot be secured by the present unjustifiable policy of "economy." The situation is one involving a principle important enough to demand immediate action by local organizations of engineers. Engineering societies have interested themselves in getting salaries raised. Why then not try to hold that which they have!

The Pittsburgh Slide

EARTH slides and slips such as the exceptionally interesting one at Pittsburgh make appeal to laymen and engineers for precisely the same ultimate reasons. They break in with startling suddenness on our everyday belief in the stability of the ground on which we travel and build, and in their nature they remain largely strange and cataclysmic, even after full study. Nearly always they contain an element of dramatic interest, too, whether in the destruction done, or in the fight to check the movement, or in the very mystery of continued creep of solid earth in response to actions that proceed out of the range of our vision and in response to obscure laws. Fortunately the Pittsburgh slide is free from the element of destructiveness, and for the time being it claims attention mainly because of the aggressive fight being made to master its progress in order that complete blocking of a railway trunk line may be prevented. At a later stage, when permanent control of the slide area is undertaken, the nature of the earth movement will have better opportunity to be studied, and deductions may become possible that can be applied elsewhere in foreseeing, preventing or controlling slides. For the present the case brings us face to face with the fact that slides especially of the flowing type are unknown phenomena in the sense that they are not amenable to prediction or to measurement; yet at the same time we know them to be related closely to other facts in the physical behavior of soils, with which the engineer is constantly concerned. Our working concepts of soils are fitted to the behavior of a normal talus slope, a mass whose superficial particles are the first to move under any disturbing influence, but they help us little in understanding how a sloping mass with stable surface may have an unstable interior in spite of the fact that every particle there is restrained by its neighbor. It is likely that the next decade or two will bring fuller investigation of earth, that will throw light on phenomena now hopelessly obscure. Until that time most slides are bound to contain a large ingredient of mystery, and we cannot hope to deal with them by other than empirical methods, and after the fact.

Hoover in a New Role

HERBERT HOOVER'S acceptance of the presidency of the American Engineering Council, the governing body of the Federated American Engineering Societies, will mean more to that organization than the inspiration of a strong leadership, important as that may be. By no other means could the engineer and his work be brought more effectively to the notice of the general public, for Hoover is *news* and any movement with which he associates himself is sure to receive recognition by the daily press, which is one of the important means by which the public can find out what the engineer is doing. One of the certain results of Mr. Hoover's work with the federation will be to make the engineer a much more important figure in the public eye than he is now. This result is urgently needed. The day after his election at Washington the big metropolitan dailies devoted much space to the proposed industrial wastes survey which he suggested as the federation's first contribution to public service and gave to the engineering profession, as a whole, invaluable publicity. In marked contrast to the recognition accorded by the press to the first meeting of the American Engineering Council are the annual meetings of other engineering societies which, if they receive any notice whatever, are dismissed with a paragraph or so, generally constituting a "filler" in some inconspicious space at the bottom of a column. It is not to be inferred, from the foregoing, that the chief aim of engineering organizations should be to have their activities reported by the daily papers. Nevertheless that result is very much to be desired, for it is a reflection of the importance with which their efforts are regarded by the world at large.

Electrification Cost Data

DEFINITE and authoritative information as to the net financial results of the Chicago, Milwaukee & St. Paul Ry. electrification, described on p. 1068, would be of the utmost value to those promoting and considering other projects for electrification, but although it is stated officially that all results are such as to warrant further application of electric traction no actual figures of these results have been made public. The electrification on the above road is of special importance from the great length of line operated and from the fact that it is a main line and not a terminal or suburban electrification. Further, the first 440-mile section has been in operation long enough to give some really reliable data.

Accepting without reservation the statement of the railway officials as to the successful results of operation, it is difficult to see why there should be such reticence as to the figures upon which the statement must be based. This reticence must tend to retard development, since engineers and executive officers cannot be expected to enter upon costly projects without some more substantial information as to actual experience on earlier projects. As a bold pioneer in long-distance main-line electrification the Chicago, Milwaukee & St. Paul Ry. is in a position to render exceptionally valuable assistance.

In respect of operating results the recent engineering discussion on steam and electric traction was barren (see *Engineering News-Record*, Oct. 28, pp. 823 and 853). It is unfortunate that the advocates of electric traction have devoted so much energy to disparaging the steam locomotive, their arguments being largely of a destructive rather than a constructive character. Great as the advantages of the electric locomotive may be its introduction must of necessity be slow and gradual. No engineer or railway man believes that the steam locomotive is within sight of being obsolete or that it has reached the limit of its development. The aim of the electrical engineer is, or should be, to show how and where and why the electric system may produce eventual economic and other advantages which will more than offset the heavy investment and the scrapping of costly existing plant. It is not difficult to do this for certain conditions of congested main-line traffic, terminal traffic, suburban service, long or numerous tunnels or heavy grades. It is much less easy to show convincingly an argument for electric traction for open main-line operation.

The description of the Chicago, Milwaukee & St. Paul Ry. electrification is of wide interest, but its value would have been increased a hundred-fold if the desired information had been made available as to investment cost, maintenance charges, operating expenses and the balance between the net cost of steam and electric traction under practically identical conditions.

Chicago, Milwaukee & St. Paul Railway Electrification

With Section Opened This Year Total Is 647 Miles, Including Heavy Grades Over Five Mountain Ranges —Types of Locomotives—Reported Operating Results

WITH the opening this year of the 209-mile electrified division of the Chicago, Milwaukee & St. Paul Ry., from Othello to Tacoma, Wash., the total length of electrification on the Milwaukee is 647 miles of main line, or 860 miles of track including passing tracks and sidings—by far the greatest in extent of electrification on any one railroad. The 438 miles between Harlowton, Mont., and Avery, Idaho, were put in electric operation January, 1916. The shorter line is operated as a single division and the longer line constitutes two divisions. Each electric division includes two divisions formerly operated by steam locomotives, as the necessity of cleaning fires of such locomotives limited runs to about 100 miles. The two electrified sections are separated by a stretch of 212 miles which is still operated by steam. This section does not present the severe operating conditions which obtain on the two adjacent sections.

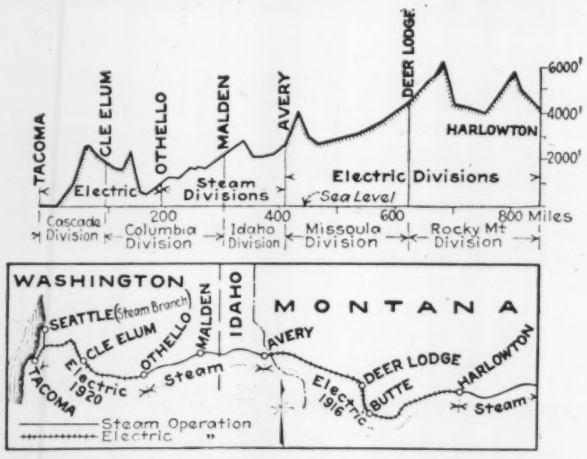


FIG. 1. ELECTRIFIED SECTIONS OF CHICAGO, MILWAUKEE & ST. PAUL RY.; 647 MILES

From Harlowton to Avery three mountain ranges of the continental divide are crossed, with summit elevations of 5,788, 6,322 and 4,150 ft. Heavy grades and a large proportion of curvature are encountered, the maximum grade being 2 per cent for 21 miles and maximum curvature being 10 deg. on the main line. Of 30 tunnels the longest is the 1½-mile St. Paul Pass tunnel through the Bitter Root range. This 440-mile stretch of electrification was described in *Engineering News* of Jan. 7, 1915, p. 22, and July 6, 1916, p. 24, and in *Engineering Record* of Oct. 23, 1915, p. 518.

The newer electrified division extends west from Othello, Wash., to Tacoma, 209 miles, with a 9-mile branch from Black River Junction to Seattle which has not yet been converted to electric traction. This division crosses two summits of the Cascade range at Boylston (El. 2,390 ft.), and in the Snoqualmie tunnel (El. 2,564 ft.), as shown by the profile, Fig. 2. Westward, the maximum grade is 2.2 per cent for 18 miles to the Boylston summit, followed by a descent of 1.6 per cent. Grades to the Snoqualmie summit are relatively easy, 0.4 to 0.7 per cent. On the western slope, however, there is a descending grade of 1.74 per cent for about 20 miles, followed by a ruling grade of 0.8 per cent for 25 miles, the latter bringing the line down to the coastal plain. There is about the same proportion of curvature as on the Rocky Mountain electrification, with the same maximum of 10 deg. for main track curves.

Power Supply and Transmission—Current for the Cascade electrification is purchased from the Intermountain Power Co. and is transmitted from the plants of two supplying companies. A transmission line of 113 miles extends from the Long Lake plant of the Washington Water Power Co. to the railway substation at Taunton, Wash. Two lines extend from the Snoqualmie Falls plant of the Puget Sound Traction, Light & Power Co. to the substation at Cedar Falls and Renton, ten and twenty miles respectively. The second of these lines continues 26 miles to the last substation at Tacoma

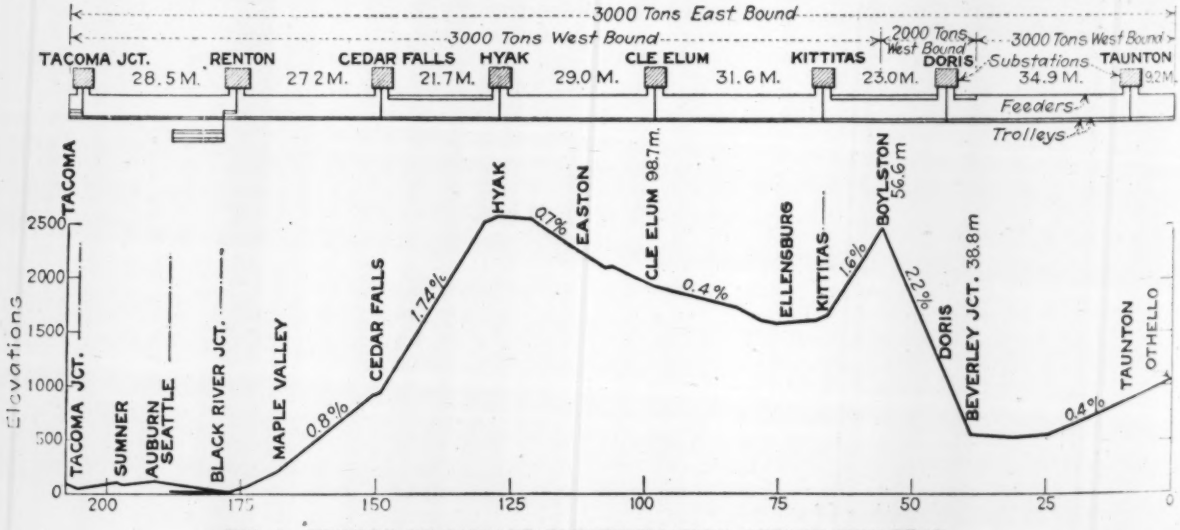


FIG. 2. PROFILE OF CASCADE ELECTRIFICATION OPENED THIS YEAR

Junction. There are eight substations, each with either one or two motor-generator sets of 2,000 kw., and space for an additional set.

Transmission lines from the power plant are carried by steel towers and wood poles. Those along the railway are carried mainly by 50-ft. wood poles with an average spacing of about 300 ft. The trolley line on main track consists of two parallel wires hanging side by side, thus giving greater flexibility and greater area of contact than a single wire. These wires are suspended by hangers from a catenary cable carried by bracket arms on single poles or by span wires between pairs of poles. On tangent line and single track poles are spaced 150 ft. For passing and yard tracks a single trolley wire is used. Current at 100,000 volts on transmission lines is stepped down to 3,000-volt direct current for the trolley wire. For the return circuit the 90-lb. track rails are supplemented by a wire carried on the poles and connected to the rails at intervals of about 8,000 ft. This wire connection serves to compensate for defective or broken rail bonds. Regenerative control or braking is a feature of the electric system, as on the older line, the motors acting as generators when the train is descending grades and delivering current to the trolley line. In this way the speed is controlled by the current returned to the line, the air brake being used mainly to stop the train and as an auxiliary while running. Automatic block signals are installed on both districts.

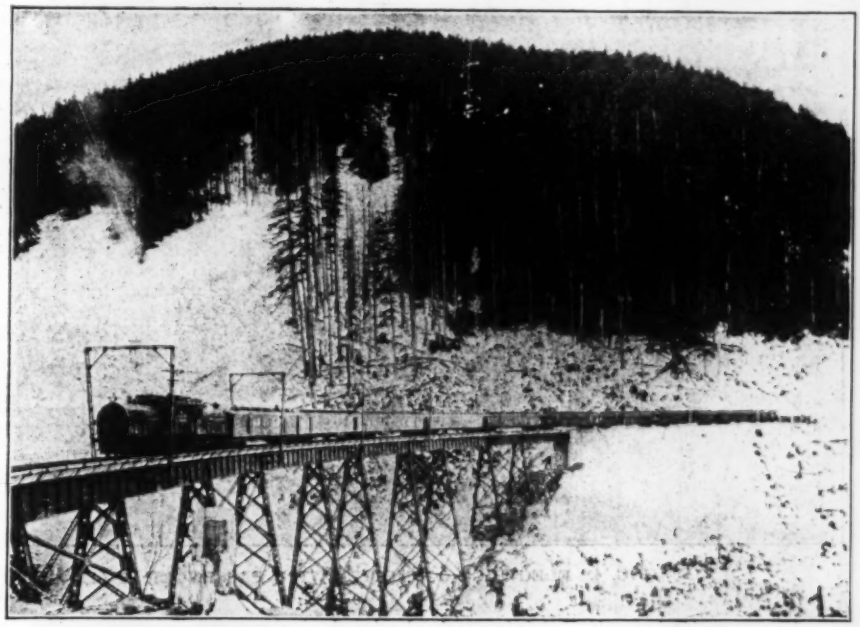


FIG. 3. PASSENGER TRAIN ASCENDING THE WESTERN SLOPE OF THE CASCADE RANGE

Locomotives and Traffic—Electric locomotives of two radically different types are employed, mainly for the reason that after extended investigations it was considered desirable to have service experience with these types under the actual operating conditions of the line. The motive power equipment of the two districts comprises 15 passenger engines, 42 freight engines and four switching engines. On each district the traffic averages two passenger trains and from three to four freight trains in each direction daily.

Freight locomotives are of the 4-8-8-4 type, composed of two connected units. Those used on the new line were formerly passenger engines on the older line, the gear ratio having been changed for freight service. In the original equipment of the older line the passenger engines were similar to the freight engines, except for a lower gear ratio, since it was thought that a suitable type of engine for passenger service should be determined on the basis of actual electric operation, the older passenger locomotives being then converted for freight service. These engines have 52-in. driving wheels with a motor of 375 hp. (continuous rating) geared to each axle. Freight train tonnage varies from 2,500 tons on 2 per cent grades to about 5,000 tons on grades of 0.4 per cent, helpers being employed on continuous grades of over 1 per cent. For passenger service, fifteen new locomotives were built in 1919, five being used on the new line and ten on the older line. They are of two different types, but are all designed to meet the railway company's requirements for hauling a train load of 950 tons (twelve steel cars) at 25 m.p.h. on grades of 2 per cent and 30 to 37.5 m.p.h. on grades of 1 per cent. The maximum speed is 65 m.p.h. on level tangents and the engines have to be sufficiently flexible to pass curves of 16 deg. in yards as well as 10 deg. main-line curves. Current is taken from the trolley line by pantagraph collectors.

On the newer Othello-Tacoma line there are five General Electric passenger locomotives having 24 driving wheels, with a two-wheel truck at each end. The wheels are grouped in four trucks with articulated connections. Each of the end trucks has six wheels, four of which are drivers while the end wheels have lateral play and have no motors. Each of the two inner trucks has eight driving wheels. The two cabs for apparatus and operating crew are integral with the eight-wheel trucks, the front of each cab being supported by rollers on its six-wheel truck. The heater cab in the middle is supported by a three-point suspension from the inside ends of the two main cabs and is carried entirely free of the trucks. Thus the locomotive forms a single and inseparable articulated unit, having both the trucks and the cab articulated. These engines are of the gearless type, with a bi-polar motor of 250 hp. (continuous rating) on each driving axle (see *Engineering News-Record*, Dec. 11, 1919, p. 1034). One of these is shown in Fig. 3.

For the Harlowton-Avery line, there are ten Westinghouse-Baldwin passenger locomotives (Fig. 4) having a 4-6-2-2-6-4 wheel arrangement (with twelve driving wheels), the running gear being composed of two separate 4-6-2 units coupled back to back but not articulated. A single cab is mounted on these two units. Each unit, with its six driving wheels, has six twin motors, each motor frame housing two armatures. The pinions of these two armatures engage a single gear mounted on a quill which surrounds the driving axle, the torque

FIG. 4. ELECTRIC LOCOMOTIVE WITH PASSENGER TRAIN AT BUTTE, MONT.

being transmitted to the driving wheels by helical springs fitted between the arms of the quill and the spokes of the wheels. The motors, which have a continuous rating of about 540 hp., are mounted on the frame of the locomotive.

In these Westinghouse engines, therefore, the six driving axles have six motors with twelve armatures, while in the other design each of twelve axles has a single motor. The main dimensions of the two types of passenger engines are given in Table I. Each engine has an oil-fired boiler with capacity of 4,000 lb. of steam per hour for heating the engine and train, and air-

TABLE I. ELECTRIC PASSENGER LOCOMOTIVES; C., M. & ST. P. RY.

	Westinghouse	General Electric
Wheel plan	4 6 2 2 6 4	2 4 8 8 4 2
Driving wheels, diameter	68 in.	44 in.
Truck wheels, diameter	36 in.	36 in.
Weight on drivers, in working order	345,000 lb.	492,000 lb.
Weight, total, in working order	562,000 lb.	551,000 lb.
Non-spring borne weight per driving axle	7,800 lb.	9,500 lb.
Total wheelbase	79 ft. 10 in.	67 ft. 0 in.
Maximum rigid wheelbase	16 ft. 9 in.	13 ft. 11 in.
Number of driving axles	6	12
Number of motors	12	12
Total tractive effort; 1-hr. motor rating	66,000	46,000
Total hp., one-hour motor rating (contract)	4,000	3,240
Total hp., continuous (contract)	3,200	3,025

compressor capacity of 150 cu.ft. per minute for the brakes, pantagraphs and other equipment.

Operating Results—In most respects the general results of electrification have exceeded expectations and in no case have they fallen below the expectations, according to R. Beeuwkes, electrical engineer of the railroad. He states that even allowing for the increased investment charges the items of operating expense depending directly upon motive power are so reduced and the additional benefits indirectly obtained are so great as to justify consideration of extending the electrification even on sections with easier grades.

A summary of cost of electrification on the older line in 1914-16 has been given recently by Mr. Beeuwkes, this cost being considered more representative than that on the new line, where the work was done under conditions of delay and difficulty due to war conditions in 1917-18. The figures in Table II cover the work for 440 route miles, 364 miles of transmission line (exclusive of lines built by the power companies), 14 sub-

TABLE II. CONSTRUCTION COST FOR 440 MILES OF ELECTRIFICATION, 1914-1916; C., M. & ST. P. RY.

	Average Cost Per Route Mile	Average Unit Costs	Per Cent of Total Costs, Exclusive of Locomotives
Trolley system complete	$8,390		47.7
Transmission system, complete	2,360		13.3
Transmission line, per mile		$2,835	
Substations, complete	6,050		34.4
Substations, each		189,400	
Substation buildings		38,400	
Substation apparatus		144,900	
Operators' dwellings		6,100	
Miscellaneous: Right of way, change to electric lines, storehouses, minor apparatus at shops and roundhouses	265		1.7
Engineering and administration, except for substations	514		2.9
Road locomotives, delivered		122,500	
Switching locomotives, delivered		37,700	
Total per route mile (exclusive of locomotives)	17,579		100.0

stations with a total capacity of 59,500 kw., 12 passenger locomotives, 30 freight locomotives and two switching locomotives. The figures in the table are intended mainly to show the relative importance of different items; they could not be applied in estimating the cost of similar work without a knowledge of the unit prices.

In Table III are shown comparative operating costs of freight traffic on the two older electrified divisions and the two steam-operated divisions adjoining them during the second half of 1918. For the purpose of comparison the figures for the Missoula electric division are taken as unity. Besides the more important reasons for the advantageous results of electrical operation, Mr. Beeuwkes considers that further improvement in operating cost is to be expected under normal conditions of operation. The marked decrease in cost of engine repairs is due to the fact that the cost of repairs per engine mile is much less for the electric locomotives than for the average steam locomotive replaced, and that the number of engine miles per 1,000 ton miles is also less on account of the greater capacity of the electric locomotive. On the Missoula division the total of engine miles per 1,000-ton miles was only about

5 per cent of that for the corresponding period in 1915 under steam operation.

TABLE III. COMPARATIVE OPERATING COSTS OF FREIGHT TRAFFIC (PER 1,000-TON-MILES); C., M. & ST. P. RY.: JULY-DEC. 1918

Division	Idaho	Missoula	Rocky Mountain	Musselshell
Motive power	Steam	Electric	Electric	Steam
Locomotive repairs	2.34	1	0.80	2.26
Traincrews	3.05	1	1.46	1.61
Engine crews	2.17	1	1.30	1.21
Fuel or power[1]	2.34	1	1.04	1.38
Enginehouse	2.50	1	0.80	3.71
Yard service[2]	1.12	1	0.99	0.71
Total of items affected by motive power[3]	1.90	1	1.11	1.33

Note: Cost on Missoula Division taken as unity.
1 The item of "Fuel" is based on the average price for the system.
2 Considerable part of the switching was done by steam, as a sufficient number of electric switching engines had not been received.
3 In addition to the items tabulated this covers superintendence and maintenance of substations, transmission and trolley systems, water and fuel stations, shops and enginehouses; also locomotive and train supplies.

Reduction in expense for train crews is due to increased tons per train-mile and increased train speed. The expenses on the Missoula division were about 10 per cent less in 1918 than in 1915, but on the Idaho steam division they had more than doubled, according to Mr. Beeuwkes. For the expense of engine crews the same conditions obtain; with only a slight increase from 1915 to 1918 for the Missoula electric division but an increase of about 100 per cent for the Idaho steam division.

The relative reliability of electric and steam operation is considered an important point. Records for the six months from Oct. 1, 1919, to March 31, 1920, show that the 440 miles of electrically-operated territory had less delay than four steam divisions aggregating 945 miles, except for the steam divisions from Avery to Cle Elum, which are particularly favorable as to climatic, topographical and other conditions tending to cause delay. A summary of these results in three districts is shown in Table IV.

TABLE IV. RELIABILITY OF STEAM AND ELECTRIC FREIGHT TRAIN SERVICE

(Time in minutes per mile of line operated for six months).

	Marmouth to Harlowton	Harlowton to Avery	Avery to Cle Elum	Average for Four Steam Divisions
Miles	340	440	325	945
Motive power	Steam	Electric	Steam	Steam
Train delays affected by motive power (*A*)	62.95	52.73	35.34	74.75
Train delays not affected by motive power (*B*)	37.85	46.30	33.86	46.77
Total	100.80	99.03	69.20	121.52
Accidents and derailments (included in *A*)	2.25	0.15	3.85	.....
Time lost	69.7	8.94	0.00	.....
Time made up	35.6	100.0	81.00	.....

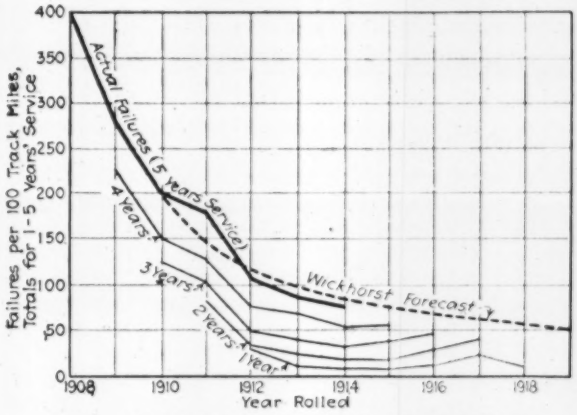
A. Delays due to other trains, signals, slow orders, excess time in switching, extra cars on train, bad weather, poor coal, trolley and substation defects, engine conditions, and accidents and derailments due to engines.
B. Delays due to waiting for connecting trains, handling heavy mail and express, extra stops, car conditions, slides, snow and accidents not due to engines.

Records for the year 1919 show that with a freight traffic of 2,476,085,000 gross ton miles behind the engines, the cost per kw.-hr. per 1,000 ton miles was 22.3c. For 378,080,000 passenger ton miles, the cost was 38.1c. per kw.-hr. per 1,000 ton-miles. The cost of power, including operating and maintenance expenses of substations and transmission lines, was 1.1c. per kw.-hr. as delivered at the locomotive.

This electrification work is under the direct charge of R. Beeuwkes, electrical engineer, Chicago, Milwaukee & St. Paul Ry.

Decrease in Rail Failures Confirmed by Latest Statistics

PUBLICATION of the 1919 rail failure statistics prepared by M. H. Wickhorst, engineer to the Rail Committee of the American Railway Engineering Association, in a bulletin just issued by the association, confirms with astonishing accuracy forecasts made four or five years ago concerning the probable future improvement in rail service. In the diagram herewith is reproduced from the bulletin the curve of rail failures during the sixth year of service (marked five years' service), and for comparison with it the forecast made by Mr. Wickhorst several years ago (shown by dash lines). In addition the curves of failures after four years, three years, two years and one year of service have been plotted from the tables in the report. The abscissa in every case represents the year during which the rails in question were rolled. The several curves are quite consistent. All of them show a hump at the year 1912, and a further abnormal rise for the years 1916 and 1917.



RAIL FAILURES FOR PRINCIPAL CARRIERS

The data of the tables cover about 85 railroads, including all the large systems of the United States and Canada and a considerable number of the shorter lines. Ten rolling mills are represented as producers of the rails. Both bessemer and openhearth rail are included, but the former is increasingly unimportant in the later rollings. Only rail lots of 1,000 tons or more were used in the tabulations, as it was concluded that a lot of less than 1,000 tons furnished by a given mill to a given railroad in one year would not affect the group totals and averages. Reduction of the data to 100 miles of track covered by the particular rolling brings the resulting figures to a uniform basis.

In the report are included detail tables and diagrams showing the performance of each lot (of 1,000 tons or over) of rail furnished by each mill to each railroad in a particular year, and summing the results for railroads and for mills in various ways. Irregular variations occur in all these summaries, however, none of them apparently tending to point in the direction of the main responsibility for rail weakness. The only consistent feature of the records is the continuous improvement shown by the diagram here reproduced. It means that the rate of failure of rails, amounting to nearly 400 per year per 100 track-miles for 1,908 rails after five years of service, has been decreased by more than 80 per cent in seven years.

Garbage Disposal in the District of Columbia

Operations for the Year Ending June 30, 1920, Reviewed—Estimates for Disposal by Pig Feeding, by New Reduction Works and by Improvements to Existing Works, Point to Latter as Most Economical

By F. S. Besson

Major, Corps of Engineers, U. S. A., Assistant to the Engineer Commissioner of the District of Columbia.

FOR the City of Washington the actual handling of garbage has been a municipal function since July 1, 1918, at which time the past practice of performance by contract had to be abandoned because of inability to make a satisfactory new contract. This work is one of the four major operations of the City Refuse Division that are today carried out wholly by municipal forces. The four are street cleaning, collection and disposal of garbage, ashes and trash.

2. The population of the District of Columbia is 437,500 and the land area 60 square miles. Garbage is not collected from outlying thinly populated sections. The area of the city from which collections are made totals 45 square miles, having an estimated population of 400,000 people. During the fiscal year ending June 30, 1920, collections were made from 62,200 private residences, 825 apartments, 400 lunch rooms and cafés, 135 hotels and miscellaneous institutions, 975 combination residences and stores and from 2,075 stores; a total of 66,610 places.

3. Throughout the year and previously during the war, the transportation by private individuals of table refuse to points outside of the District of Columbia was permitted. This license was taken advantage of by a number of pig feeders and always caused more or less unsatisfactory conditions. Also these private collections meant a real loss to the District in that the pig feeders selected only the garbage richest in fats from cafés and similar places, leaving for the District forces all the smaller lean collections. The amounts taken for these private enterprises fluctuated greatly from day to day and varied with the seasons of the year. The collectors had no responsibility; they would sell their pigs and with notice to no one discontinue collections with resultant complaints by the Health Department and calls upon the City Refuse Division for emergency collections.

4. The appropriation act for the fiscal year ending June 30, 1921, contains a provision repealing the law that permitted private collections and now the District has full control over all table refuse in the city. It is estimated that this repeal will add at least 10 per cent to what the collections would otherwise be under former conditions. Garbage service is rendered daily by the City Refuse Division during the months April to October inclusive and three times a week during the remainder of the year. The maximum monthly collection during the fiscal year ending June 30, 1920, was 5,863 tons during August and the minimum 3,401 tons during February. The total for the year was 52,800 tons, or 1,585 lb. for each of the 66,610 premises; or 264 lb. per capita based upon the 400,000 from whom collections are made.

5. The dividing line between collection and disposal is taken as being immediately after the transfer station receives the garbage from the collecting units and delivers it to the transportation equipment belonging to the disposal plant. Disposal therefore consists of (1) transporting the refuse from the central transfer station located at New Jersey Ave. and K St. S. E., within the city, to the reduction plant at Cherry Hill, which is on the Richmond, Fredericksburg & Potomac R.R., 31 miles south of Washington; and (2) extracting grease and reducing the garbage to tankage for fertilizing purposes.

6. In 1918, when the work was first started by city forces, plant and equipment were obtained from the contractor who had previously had it in hand. Most of the property was very old and almost worn out. The reduction plant had been used for twenty years continuously for the disposal of Washington's garbage. The amount paid the contractor was $49,890. Making allowance for depreciation and betterments during the year, it may be estimated that the value of the reduction plant on July 1, 1919, the beginning of the fiscal year, was $50,000, and of the transportation equipment, $8,000.

7. The city, at the beginning of the year, July 1, 1919, owned 16 rack cars, all of which were so old that not more than 50 per cent of them could be maintained in service at any one time. A rack car is capable of carrying approximately 20 of the wagon bodies in which the garbage is collected. These bodies are of sheet metal and hold slightly more than 2 cu.yd. or 1.4 tons of refuse each. They are lifted bodily from the running gear of the wagons and replaced by empty ones. This number of rack cars is not sufficient and therefore gondolas are rented from the railroad company. The garbage is dumped from the collecting units into these, a large gondola holding about 55 tons. The transportation account for the year totaled $29,243, itemized as follows:

Six per cent interest on investment of $8,000	$480
Twenty-five per cent depreciation of $8,000	2,000
Repairs and maintenance	2,400
Gondola rental at $3 per day	5,268
Freight, 1,273 car trips at $15 per round trip	19,095
Total transportation expense	$29,243

52,800 tons carried at a rate of 55½c. per ton.
Value of equipment July 1, 1920—$6,000.

8. Upon arrival at Cherry Hill the tank bodies are hoisted to the second floor of the plant and emptied onto the receiving platform. In the case of gondola cars a clam-shell bucket is used for raising their contents. The garbage is cooked in Chamberlain digestors and pressed in Thomas-Albright hydraulic rack presses. The liquids are passed through settling and skimming basins and the grease removed. The pressed cake is dried in a direct heat dryer and sold as tankage. The plant account was as follows:

Six per cent interest on investment of $50,000	$3,000
Twenty per cent depreciation of $50,000	10,000
Rent for land	116
Total	$13,116
Value of plant July 1, 1920	$40,000

9. The operating account, including force for repairs and maintenance, for reduction was as follows:

Supervisory:		
Administration	$3,000	
1 Superintendent	2,740	
1 Assistant	2,340	
1 Timekeeper and clerk	1,200	
2 Watchmen	3,000	
		$12,280

POWER PLANT AND REPAIR SHOP:		
3 Engineers	$5,320	
3 Firemen	5,200	
5 Laborers	6,600	
1 Seamstress	350	
		17,470
UNLOADING RAW GARBAGE:		
1 Engineer	$1,660	
6 Laborers	8,300	
		9,960
COOKING AND PRESSING:		
3 Cookers	$4,500	
8 Pressmen	9,800	
18 Laborers	18,800	
		33,100
DRYING SECTION:		
1 Fireman	$1,560	
5 Laborers	7,950	
		9,150
MISCELLANEOUS:		
1 Foreman	$1,250	
1 Greasman	1,650	
9 Laborers	12,800	
		15,700
Total operating account		$98,020

10. Expenses for supplies, including those for repair and maintenance, were as follows:

Unloading	$1,284
Boiler room	31,886
Engine room	4,799
Pressing equipment	33,007
Drying	1,433
Miscellaneous	5,255
Total supplies	$77,664

11. The total expenditures for disposal of the city's garbage were therefore comprised of the following:

Par. 7. Transportation	$29,243
Par. 8. Reduction plant	13,416
Par. 9. Operating account	98,020
Par. 10. Expenditures for supplies	77,664
Total disposal charge	$218,343

The 52,800 tons collected were thus disposed of at a rate of $4.15 per ton.

12. In treating pressed cake in order to make a salable tankage a residue of cans, metals, paper, etc., called tailings, is obtained which during the year amounted to approximately 2,500 tons or 4.7 per cent of the total. Since the plant is equipped with neither magnetic separator nor grinder the tailings in a combined state had to be wasted on a near-by dump. From the settling basins after removal of the grease a liquid called tank water had to be wasted. The grease extracted amounted to 1,853,496, or 35 lb. per ton of raw garbage, a grease salvage of 1.76 per cent. It sold for an average of 9.7c. per lb. Tankage amounted to 3,048 tons or 0.058 tons per ton of raw garbage, a showing of 5.8 per cent. It sold for an average of $12.11 per ton. By percentages the garbage analysis was therefore: Grease, 1.76; tankage, 5.8; tailings, 4.7; stick, moisture lost in cooking, etc., 87.74. Receipts from sales summed up as follows:

1,853,496 lb. grease	$179,668
3,048 tons tankage	36,922
Total receipts	$216,590

For the 52,800 tons of raw garbage collected, receipts were obtained at the rate of $4.10 per ton.

13. Total charges were $218,343. Total receipts, $216,590, and the balance of $1,753 shows the cost to the district for garbage disposal. Based upon the 400,000 from whom collections were made the per capita cost per annum was slightly less than one-half cent. On a tonnage basis the figures are:

Par. 11.	$4.15 per ton charges.
Par. 12.	4.10 per ton receipts.
	.05 cost to District.

14. There is a feeling current that the Washington reduction plant has passed its economic period and that its continued use is but a temporary expedient. It has been proposed that disposal should be by sale to pig feeding contractors. An alternate proposal has been the building of an entirely new plant at a location other than the present, and also a combination of these two schemes has been contemplated. In addition, in the paragraphs following, consideration is given to an elaboration of the present plant as advocated by both Mr. Hacker the Supervisor of City Refuse, and Mr. Crane, the Superintendent of Garbage Reduction. It must be realized that garbage disposal is not carried on because of its profit-making possibilities. It is one of the essentials of city life and only such economies may be considered as are justified from the standpoint of public health and welfare.

15. Under the law garbage may not be fed to pigs within the limits of the District of Columbia. A farm for the purpose would of necessity therefore be located either in Maryland or in Virginia and the persons handling the enterprise would have to be conversant with and adhere to the laws of the state relative to the admission, quarantine and maintenance of pigs brought therein for feeding purposes. It may be considered that transportation from the city transfer station to the farm might be either by rail or by truck, though it will be found that a site suitable for either is very difficult of obtainment. In the case of rail haul, by taking over the District's present equipment, the contractor's shipping expense, if his farm were located within the minimum rate area, would be 55½c. per ton. If the pig farm were so located that rail shipment could not be made, trucks would have to be used, in which case it may be stated that a location could not be found with a haul sufficiently short to permit more than a maximum of three trips daily for each truck, which operating experience shows would be about 800 trips per year.

16. If a fleet of 5-ton dump trucks were used charges per year for each would be as follows:

Drivers wages	$1,400
Depreciation (20 per cent on $6,000)	1,200
Interest (6 per cent on $6,000)	360
Insurance	450
Garage	200
Maintenance, minor repairs, and supplies	350
Complete overhaul once a year	600
License fees	150
Tires	900
Lubricants	150
Gasoline	1,050
Total for 800 trips	$6,810
One trip with delivery of 5 tons of garbage	$8.50
Rate per ton	1.70

A scheme using trailers might be worked out satisfactorily under the city's traffic regulations to do this hauling at somewhat less than the above but in any case the rate would be much above that of 55½c. for rail transportation.

17. The City of Washington is in a position to guarantee to a contractor two conditions vital to garbage feeding: (1) Excellent separation. The municipal regulations are sufficient for this purpose at present and are enforced, so that the presence of ashes and trash in the garbage is minimized. (2) All the garbage accumulated in the city where collection service is rendered would be supplied the contractor (see par. 4). He would not lose the rich garbage because of private collections. His supply would be steady and affected by seasonable conditions only and not by the erratic collections of miscellaneous pig feeders. Feeding tests under District of Columbia conditions give the following data pertaining to such an enterprise as is under discussion. An average of 7,000

pigs is necessary for the daily consumption of 52,800 tons of garbage; 7,000 feeders, 105 lb. each, at 15c. per lb. require an investment of $110,250. Complete installation for farm @ $10 per pig is $70,000. The herd should have a complete turnover three times yearly, the pigs selling at a weight of 225 lb.

YEARLY DEBITS

Purchase of 21,000 pigs, each 105 lb., at 15c.	$330,750
Six per cent interest on feeder investment, $110,250	6,615
Six per cent interest on installation investment, $70,000	4,200
Ten per cent installation depreciation	7,000
Farm rental	1,000
Immunization and dipping at $2 per pig (21,000 annually)	42,000
Shipping and quarantine costs at $2 per pig	42,000
Medical attention at 50c. per pig	10,500
Five per cent of 21,000 or 1,050 pigs lost, sickness, etc.	16,537
Labor at $1.50 per pig	31,500
Transportation, 52,800 tons at 55½c.	29,304
Six per cent on working capital of $100,000	6,000
Premium on surety bond	1,000
Overhead	15,000
Total debits	$543,406

The sum realized from the sale of 19,950 pigs, each weighing 225 lb., @ 15c. per lb, amounts to $613,312, showing a yearly credit balance of $129,906.

18. This analysis tends to the belief that certainly a prospective pig feeding contractor would be willing to pay a considerable sum for raw garbage f.o.b. his transportation equipment at the District's transfer station. Prior to accepting such a conclusion as final it should be noted that the data which have been presented are based on favorable circumstances and good pig management, two conditions that the history of garbage feeding shows are not often existent. It has been assumed that the selling price per pound of the pigs would be the same as the purchase price. With a long-term contract, of five years at least, under ordinary conditions this assumption would probably be true; purchases and consequent sales would be made as often on a rising market as on a falling one. But under present-day conditions it can hardly be expected otherwise than that, though there may be fluctuations up and down, the general trend during the coming five years will be downward. Accordingly, if in the yearly operating account set forth herein the sale price were but one cent lower, or 14c., with a purchase price of 15c., the credit balance would be reduced to $85,019.

19. In case an economical site could not be obtained for pig feeding with rail shipment, it would be no more than conservative to estimate that transportation charges by truck would be $1.70 per ton instead of the 55½c. used in the account statement. This would further reduce the credit balance to $24,563. By good pig management, it is possible to hold hemorrhagic septicemia and other losses down to the 5 per cent allowance entered in the data, but 10, 15 and even 20 per cent losses have been all too common throughout the country. Under such conditions the credit balance would be further lowered to a point where, even if receiving little or no payment for the garbage supplied, the District would undoubtedly have a failing contractor on its hands. The chances that this combination of events might occur are so great that the District would have to keep the reduction plant in readiness for use on short notice. This would mean an expense of $10,000 yearly, which would include capital charges, watchmen, fire protection and proper maintenance. Also there would be certain expenditures necessary for administrative and inspection purposes.

20. A feeding enterprise from a contractor's viewpoint can be operated successfully only when prospective profits are sufficiently large to allow leeway for all contingencies. It is thought that worthwhile bids would not be received for the delivery of garbage, f.o.b. contractor's equipment at the District transfer station. Confirming this statement is the fact that bids in other cities per ton of garbage for deliveries f.o.b. the feeding farm have varied from three to eight times the price per pound of live hogs on the Chicago market. With the contractor charged with the transportation from the city to the farm, the prospects of receiving any offer at all are entirely wiped out. In order that pig feeding may give satisfactory results it must be reasonably certain that the contractor will make a fair profit. With this in mind, it is evident that from the municipal viewpoint a feeding project cannot compare favorably with the money returned and satisfaction guaranteed the public under the present conditions of disposal by reduction.

21. Detailed estimates have been made covering two types of proposed new reduction plant. These two are usually known, one as the Cobwell, which reclaims the grease through solvent stills without the use of mechanical presses, and the other as the Chamberlain, which is similar to the existing plant, with the addition of percolators. Without entering into the relative merits or costs of these two systems it may be stated that the least practicable amount for which a new plant could be constructed has been determined to be $700,000. The plant account for such an outlay would be as follows:

Ground rent	$1,000
Six per cent interest on investment	42,000
Six per cent depreciation	42,000
Total plant charge	$85,000

22. The operating account, including force for repairs and maintenance, would be:

Supervisory	$15,000
Power plant and repair shop	20,000
Unloading raw garbage	5,000
Cooking, etc.	16,000
Drying section	10,000
Miscellaneous	10,000
Total operating account	$76,000

23. Expenses for supplies, including those for repairs and maintenance, would be as follows:

Unloading	$1,300
Boiler room	60,000
Engine room	7,500
Drying	2,000
Processing equipment	40,000
Miscellaneous	5,000
Total supplies	$115,800

24. Various sites have been proposed for the location of a new plant. Some would require barge transportation, others rail. In any case it would be fair to assume that transportation charges would be the minimum possible under most economical conditions (see par. 31). The total expenditures involved in the adoption of this $700,000 new proposition would then be:

Par. 31.	Transportation	$20,860
Par. 21.	Plant account	85,000
Par. 22.	Operating account	76,000
	Supplies	115,800
	Total disposal charge	$297,660

Based upon a collection of 52,800 tons the disposal rate would be $5.64 per ton.

25. The grease and tankage recovery with this new contemplated plant would be appreciably greater than under existing conditions. The quality of grease would be such as to demand a somewhat lower price than is received for Cherry Hill grease. For comparative purposes it may be assumed that the money return from grease and tankage would be approximately 20 per cent

greater than that shown for the fiscal year 1920 as stated in par. 12 herein.

26. Total charges would be $297,660, total receipts $260,000, and the balance of $37,660 would show the cost to the District for garbage disposal. On a tonnage basis these figures would be:

Par. 24. $5.64 per ton charges.
Par. 25. 4.92 per ton receipts.
.72 per ton debit using new plant.
For comparison with
Par. 13. .05 per ton credit under existing conditions.

27. It is necessary to work two labor shifts with the present equipment at Cherry Hill. Using the existing buildings and substituting large digesters and improved pressing and garbage conveyor equipment, it would be practicable to handle the work, running a day shift alone, for about nine months of the year and a day and night shift three months during the summer rush. The improved installation would afford a considerable labor saving, estimated at $18,000 yearly. Twenty 6-ft. diameter digesters could be installed, four of the smaller 4½-ft. size would remain because of limited space available in certain bays of the building. A green-garbage conveyor in the upper part of the building would permit direct spouting into the digesters, thereby doing away with a great deal of the present manual labor.

28. Two digesters of the type desired have already been installed and others must be installed in the immediate future. At least four of those now in use will have to be discontinued, even if extensive repairs were made, within the next six months, due to failure to pass the boiler inspector's test. The proposed reconstruction of the plant may be considered as of date July 1, 1921, at which time the value of the existing plant would be $30,000.

29. The necessary expenditures would be:

Digester equipment	$50,000
Pressing equipment	34,000
Conveyors	12,000
Magnetic separator	3,000
Grinder for tailings with building	10,000
Recovery of stick in tank water	10,000
Engine room betterments	15,000
Increased boiler capacity and building	10,000
Main building construction	25,000
Total	$169,000

This sum added to the $30,000 investment represented by the existing installation would give a total of $199,000 and a plant account as follows:

Ground rent	$461
Six per cent interest	11,940
Eight per cent depreciation	15,920
Total plant charge	$28,321

It may be noted that no provision is made for percolators. They are omitted because of the determination that the value of the additional grease obtained would not compensate for the extra fuel and solvent consumption required for percolators.

30. The elaborated plant would show a saving of $18,000 in labor and $15,000 in supplies over that of the plant today, on which basis the operating account would be $80,020 and the supplies account $62,664. The returns from the sale of grease and tankage would approximate 10 per cent more than those of today, thereby giving a total of $238,249.

31. To complete the development of the project estimates should provide for improved transportation facilities. The sixteen rack cars owned by the District and used for carrying the wagon bodies to Cherry Hill are in such continual bad order that it is imperative that they be replaced at the earliest opportunity. In doing so advantage should be taken to change from the present use of rack cars to that of entire use of gondola cars. Ten such cars would ordinarily be sufficient, and others would have to be rented during peak loads. Transportation expenses subject to the adoption of this scheme would be as follows:

Six per cent on investment, $37,500	$2,220
Six per cent depreciation	2,220
Rental of cars at $3 per day	1,020
Freight on 960 car trips (round trips) at $15	14,400
Maintenance	1,000
Total transportation charge	$20,860

On a basis of a collection of 52,800 tons per year, this charge would be at the rate of 39½c. per ton. The saving over the charges sustained in using the present equipment is a total of $8,383 or 16c. per ton. Even though this favorable saving were not shown the ten gondolas should be obtained. Means for taking the garbage from the transfer station must be certain and dependable and this is not the case at present. As many as 51 collection wagons have been seen lined up waiting for cars so that they could be unloaded. Such delay interferes materially with the collection service and can be entirely obviated by purchasing the new gondolas.

32. The total charges using the reconstructed plant and improved transportation would be as follows:

Par. 29.	Plant account	$28,321
Par. 31.	Transportation	20,860
Par. 30.	Operating account	80,020
Par. 30.	Supplies	62,664
	Total disposal charge	$191,865

With receipts of $238,249, the balance to the credit of the District for garbage disposal would be $46,384. On a tonnage basis these figures would be:

$3.63 per ton charges.
4.51 per ton receipts.
.88 per ton profit using elaborated plant.
For comparison with
Par. 13. .05 per ton debit today.
Par. 26. .72 per ton debit entire new plant.

33. With rejection of pig feeding projects, the comparison of the plant today with an entirely new proposition and with an elaboration of itself shows conclusively in favor of such present plant development. The figures used in the comparison are all based upon those pertaining to operation during the fiscal year ending June 30, 1920. The freight charge per round trip from Washington to Cherry Hill was assumed at $15. A few years ago it was but $7, and in the immediate future it may be $25. Fluctuations in freight costs, labor wages, byproducts selling prices, etc., would not affect the conclusions. It is plainly evident that an expenditure of $169,000 for the reduction plant proper and $37,500 for transportation would be real economy. In addition the expenditures are necessary from a sanitary viewpoint and in order to do away with the unsafe working conditions at the reduction plant.

Directory of State and Insular Health Authorities

A directory of state and insular health authorities for the current year appears in *Public Health Reports* (U. S. Public Health Service, Washington, D. C.,) for Aug. 6, 1920. Names and addresses of the members of the boards are given, together with those of executive state health officers and department heads. The appropriations for the fiscal year or biennium are also given. Full-time health officers and department heads are indicated. In contrast with earlier directories, professional degrees other than M.D. are reported.

The Bigelow Boulevard Slide at Pittsburgh

By Maurice R. Scharff
Vice President and Assistant Chief Engineer, Morris Knowles, Incorporated, Engineers, Pittsburgh, Pa.

ENGINEERS in the Pittsburgh district have had considerable experience with earth slides. Clays which when watersoaked provide excellent lubrication for sliding surfaces are found on the hill tops of the region on top of the flat-bedded shales, drifted in the hollows and gullies, and occasionally stratified between beds of shale. These conditions with the steep slopes and the long periods of rain met with from time to time have given the district a reputation for slides, particularly in connection with highway and railroad construction.

Some of these past slides have been of substantial magnitude. The Mt. Washington slide on the Panhandle Division of the Pennsylvania Lines West, for example, deposited about 150,000 yd. of shale and clay upon two of the four tracks of the railroad opposite the Point at Pittsburgh in 1902, and required two steam shovels, working for several weeks, for its removal. Another important slide destroyed several hundred feet of third and fourth track construction on the Ft. Wayne Division of the Pennsylvania near Beaver Falls in 1901 and eventually required a relocation, after more than 100,000 yd. had been removed. And a slide on the construction of the Brilliant Cut-Off of the Pennsylvania R.R. in 1904, involving the motion both of a fill and the underlying shale, threatened for a time the Brilliant pumping station of the Pittsburgh water-works, then under construction.

The slide now in progress east of the Union Station at Pittsburgh is distinguished from those that have gone before in three principal respects: First, because the depth and quantity of earth in motion is probably somewhat larger than in any of the cases mentioned; Second, because the present slide appears to have its origin in the disturbance of the equilibrium of filled material, no evidence yet being available of any contributory failure in the natural ground or the underlying shales; and third, because, by virtue of its location, it has threatened to cut in two both an important local traffic artery and a great trunk line railroad system.

A brief news report was published in *Engineering News-Record* a week ago. It is now believed that some further details will be of interest. It will be necessary to wait until some future time, however, when additional data shall have become available, before the weight to be given to the several contributory causes, and the steps to be taken to repair the damage and prevent future difficulty, can be intelligently discussed.

The portion of Bigelow Boulevard (originally Grant Boulevard, but renamed after Edward M. Bigelow, Director of Public Works, who conceived and carried out the project) adjacent to Kirkpatrick St. was constructed in 1898, following the contour at the upper end of Jones Hollow, a steeply sloping gully. The location is shown in Fig. 1 herewith, although the topography shown was taken in October, 1920.

*Special attention is directed, in connection with the present full report, to an error contained in the preliminary telegraphic report printed in our news pages last week (p. 1058). Mr. Scharff, author of that report as well as of the present one, advises us that misinterpretation in transcribing and combining two dispatches containing the report resulted in making him appear to state an opinion which he does not hold, namely that the slide was caused or started by the dumping of earth in the fill for the improvement of the boulevard. Mr. Scharff states that it was his intention to refrain from any expression as to cause, as being premature at this time; that a number of different factors may all or any of them have been contributory, to an extent not yet determinable; and that it would be imprudent at this time to express any final opinion as to the cause of the slide.—Editor.

Historical

In connection with the Boulevard construction an ashlar masonry wall consisting of a curved central section about 100 ft. long and two curved wing-walls about 40 ft. and 70 ft. long was built in the lower part of the hollow, as shown in the plan. The center section had a maximum height of 63.04 ft., and thickness as shown by a section adjoining the map. The foundation and the ends were tied into the solid shale.

As fill from the Boulevard construction was placed in the hollow during 1898, cracks developed in both wing-walls, and engineers for the Pennsylvania R.R. recorded an outward movement of the top of the center wall which reached about 4½ in. The filling was then stopped, and, the weep holes in the wall being stopped up, a hole was drilled through the base, releasing a considerable amount of impounded water, after which the wall settled back, closing the cracks. The weep holes were then cleaned out, and broken stone placed back of the base of the wall for drainage to the drill hole. Two catchbasins, connected to a 24-in. terra cotta sewer, were also installed back of the wall to prevent the accumulation of surface water.

The fill for the 60-ft. roadway of the Boulevard was then completed, placing a rock-filled wooden crib at the toe of the slope, about 100 ft. above the wall, to relieve the wall of further thrust. This crib was completed in October, 1899, and the fill was placed back of it in layers, starting at the crib and working up to the roadway, being completed in April, 1900.

About five or six years later a slip developed on Jones Ave. (now Brereton Ave.) at the east side of the hollow, and wooden cribbing and piling were put in below this roadway in order to maintain it.

Ever since the completion of the Boulevard the Bureau of Highways and Sewers, which is charged with the maintenance of Pittsburgh's streets, has used Jones Hollow as a dumping place for material removed from the Boulevard and other street cleanings, including a certain amount of clay and shale which after heavy rains has washed down upon the lower end of the Boulevard from the steep hillsides above it. In addition, contractors and others have from time to time been permitted to waste material at this point. In this manner a considerable area of ground was made outside the curb, which formerly constituted the top of the slope, and the frame city stable north of the Boulevard (shown in the map) was built on this fill.

During the current year plans were completed for improving the Boulevard by a retaining wall along its uphill side, some distance west of Jones Hollow, to prevent the washing down of material from the hillside. It was also determined to relocate the Boulevard at Kirkpatrick St., eliminating the present curve and securing increased traffic capacity by maintaining the present roadway in addition to the new one, with a safety island

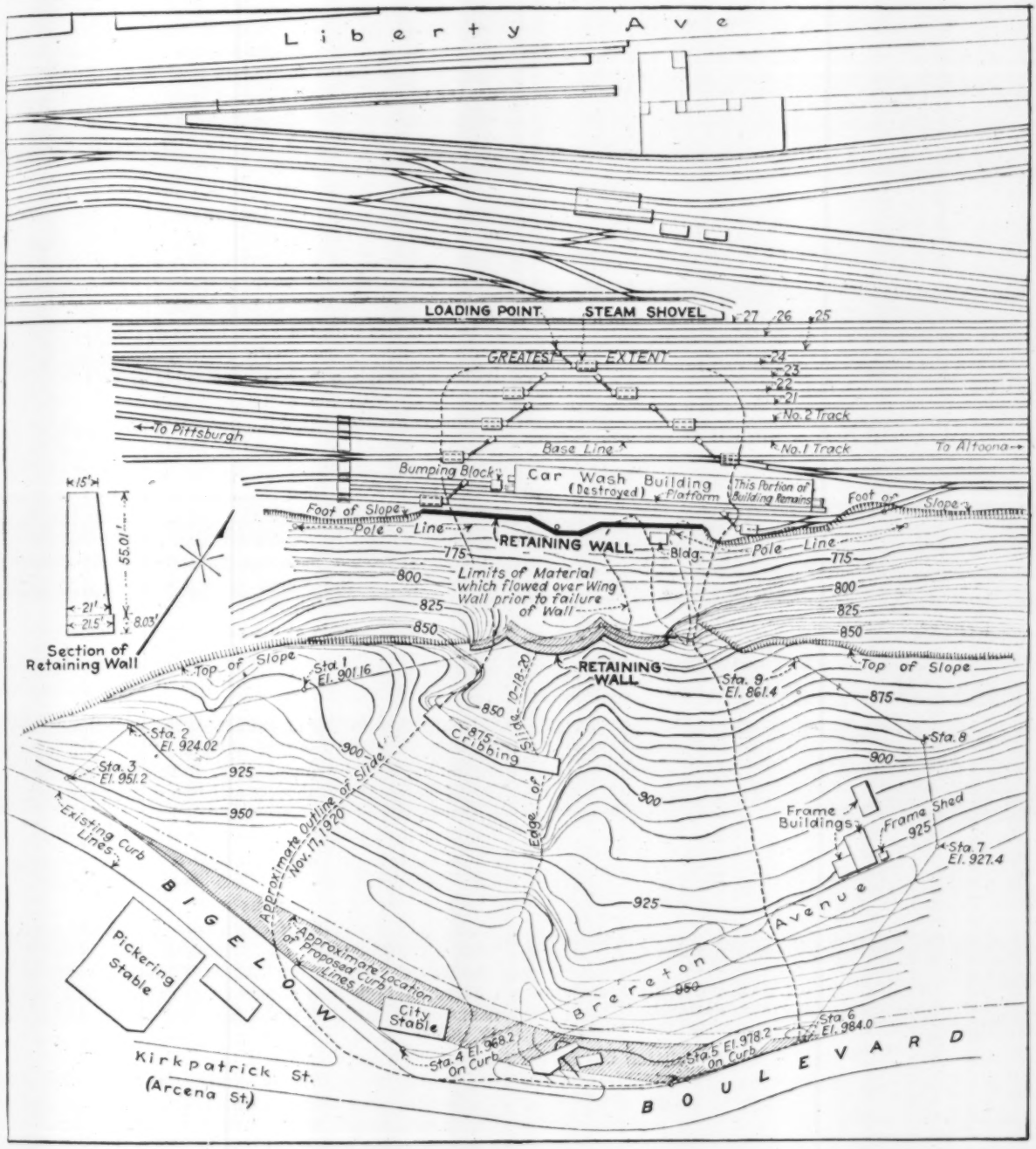


FIG. 1. PRIOR TOPOGRAPHY AT SLIDE SITE BELOW BIGELOW BOULEVARD, PITTSBURGH, WITH INITIAL AND MAXIMUM SLIDE LIMITS

between. This work was commenced several months ago, and beginning about August, 1920, material from excavation for the retaining wall has been placed in position for the proposed fill.

Early in October, 1920, settlement of filled material adjacent to the Boulevard was observed, and about the middle of the month engineers for the Pennsylvania R.R. observed material flowing over the east wing-wall of the retaining wall. At the same time the old cracks in the wing-walls were noticed to be opening up, and these cracks continued to widen at the rate of about 1 in. a day.

Some effort was made to unload the fill, using a clam-shell bucket at the Boulevard, and some material was thrown over the retaining wall from just behind it, using shovels and wheelbarrows. But before anything could be accomplished the east wing-wall collapsed, and finally, on Oct. 29, the top 30 ft. of the center wall fell. Fig. 2 shows the wall just prior to its failure.

The fill adjacent to the Boulevard then commenced to settle more rapidly, developing extensive cracks, as shown in Fig. 3, taken Nov. 5. The Boulevard roadway also was cracked at this time, and part of it sank. A timber bridge, supported on wooden piles driven down to the rock, was then constructed and has made possible the continuance of the Boulevard in use up to the present writing (Nov. 26). Some of the piles have moved a few inches, but the bridge has been

closely watched and shored and braced wherever settlement appeared, so that it has continued to be safe for use. Traffic has, however, been much retarded, due to the constriction at the bridge.

The Effects

The most serious effects of the slide, however, have resulted from its invasion of the main line passenger tracks and the passenger car yards of the Pennsylvania R.R. at the foot of the hill. When the retaining wall failed on Oct. 29 a large section of it struck the west end of the inspection and supply building, a two-story-and-basement brick building 30 x 290 ft., and demolished a portion of the building up to the first firewall. Later, two more sections had to be pulled down.

When the top portion of the wall failed the remainder of the wall and its foundation turned slowly through about 90 deg. in place, retarding the movement of the earth above until Nov. 2, when it moved out, burying

FIG. 2. RETAINING WALL BADLY CRACKED, VIEWED ON DAY OF FINAL FAILURE
East (far) wing has already collapsed, west wing has split.

itself in the nose of the slide and permitting the motion of the material to proceed at a more rapid rate. The slide, carrying in front broken fragments of the wall, moved across the tracks immediately adjacent to the hillside and on Nov. 4 reached the main-line passenger tracks (Nos. 1 and 2 on map), putting them out of commission.

The extent of the invasion of the yard by the slide is shown by the map, though this does not fully indicate its relation to yard operation. In all, eight tracks were put out of commission by the slide, and, inasmuch as it was necessary to use three additional tracks for shifting and classifying dirt cars, the railroad had left for handling all of its heavy traffic east of Pittsburgh, and the necessary shifting and express car operations in this portion of the yard, only eight additional tracks.

Furthermore, it was recognized that there was danger, in case of long-continued heavy rains, of the slide moving so rapidly as to cut the entire yard in two all the way through to Liberty Ave. It therefore became necessary to make plans for diverting all traffic. They involved the use of East Liberty as the local terminal station for all trains originating or terminating at Pittsburgh and serving the territory on the main line east, while similar trains for points west would continue to use the Union Station. Through trains would be diverted via the Brilliant Branch to Federal St. station, and via the Port Perry Branch and the Monongahela Division to Smithfield St. station.

One of the interesting features observed by the railroad engineers was the heaving up of track in front of the nose of the slide. In some cases tracks were raised as much as 10 ft. vertically, and the tracks on which steam shovels were operating were repeatedly destroyed and required to be rebuilt.

Interference with trackage, however, was not the only form of interference with railway operation. Four trunk telegraph and telephone cable lines connecting Pittsburgh with the eastern part of the system and originally located behind the inspection and supply building were moved to the front of the building and placed underground several days before the wall failed in order to prevent their loss. Even in this position, however, they were not long safe and it was necessary to remove them twice again to successively more distant underground locations before they were placed finally beyond the reach of the nose of the slide. Water, Pintsch gas, steam and compressed air lines and a car-charging cable also were cut by the earth movement.

Removal of Earth

In anticipation of the failure of the wall the railroad engineers had two steam shovels on the job at the beginning, and by about Nov. 6 this equipment had been increased to 9 shovels and two ditching machines, with one shovel in reserve, which have been in operation ever since—one of the largest concentrations of shovel equipment within so small a space ever seen in the Pittsburgh district. This equipment includes 10 Barnhart, Atlantic, Bucyrus and Marion shovels, with 2½ to 4-yd. buckets, and two Erie revolving shovels with ⅝-yd. buckets. The arrangement of the steam shovels, as shown on the map, is interesting, as it illustrates how it became necessary to *échelon* them on the flanks of the slide, so that each could protect the shovel to the front of it from envelopment by the moving earth. This formation was carried out all the way to the nose of the slide, one shovel attacking at the nose and loading on a through track, while all other shovels loaded on adjacent tracks cut by the slide, loaded cars being classified and assembled on three through tracks and eight cut tracks. Dirt was loaded on 77 Clark steel side-dump cars of 30 cu.yd. capacity each and 300 12- to 16-yd. wooden dump cars, which were obtained on short notice from contractors all over the territory surrounding Pittsburgh. In addition 1,200 50-yd. gondolas have been loaded.

Flood lights mounted on poles have been maintained to illuminate the work at the slide, as well as at the dumps, and work has proceeded continuously 24 hours a day since the beginning.

The available shovel equipment is estimated to have a capacity of 30,000 cu.yd. per day, but due to the necessity of compromising with railroad operation and to the difficulty of disposing of loaded cars as promptly as they are loaded the actual output has averaged only 6,000 or 7,000 yd. per day, and the total removal to the time of this writing (Nov. 26) is in the neighbor-

FIG. 3. FISSURING IN MADE GROUND AT TOP OF LOWER SLOPE, SHORTLY AFTER START OF SLIDE
View taken Nov. 5. Pavement of boulevard to left of picture developed many large longitudinal cracks at this time.

hood of 80,000 or 90,000 yd. This has not only kept up with the movement but has made substantial inroads on the slide. Of the eight tracks put out of service two have been partially recovered already and it is momentarily expected at the time of this writing that the two main-line tracks can be cleared.

Throughout these operations the railroad engineers have made frequent observations on the rate of motion of the slide, establishing transit points on the tops of the neighboring hills and making measurements upon stakes set in top of the nose of the slide. The rate of motion so observed has varied from about 1 ft. per hr. at the commencement of the principal movement on Nov. 2 down to a minimum of about ½ in. per hr. on Nov. 20 and 21. Following light rains on the latter date the motion increased on the following day to about 6 in. per hr., but has now decreased again to between 1 and 3 in. per hr. During the same period the top of the nose of the slide, which rose at one time about 45 ft. above the level of the tracks, has settled approximately 10 ft.

ORGANIZATION

One of the most interesting features of the dirt removal operations is the organization which has been built up by the engineer in charge for the railroad. In the beginning it was necessary to utilize existing facilities for shifting and classifying dirt cars, and this required running dirt trains into the portion of the yard just east of the Pennsylvania Station controlled by the interlocking system and removed them effectively from the control of the force in charge of dirt removal.

The engineer in charge, however, succeeded in getting authorization to stub-end the main-line tracks beyond the interlocking system and to cut in ladder tracks at both ends, so as to throw the main-line tracks into the passenger car yard and to convert this yard into a self-contained system which could be used most effectively for pushing the work. Within this yard the engineer in charge has built up a complete, independent railroad organization having, in addition to the construction forces and equipment and rolling stock already mentioned, a complete staff of day and night yardmasters, dispatchers, electricians, repair men, etc. The possibility of developing this centrally controlled organization is believed to have contributed considerably to the success of the work that has been done.

GENERAL

While the work of dirt removal has gained considerably on the slide it is recognized by those in charge that all danger has not yet passed. A large quantity of earth remains to be removed, and though the exact quantity is not known it may well run to several times that which has already been removed. It is still possible, therefore, that long-continued heavy rains might start a movement that would add materially to the damage already done. To the time of this writing, however, the weather has continued reasonably satisfactory, and with good progress the work will be completed without further interference with operations.

Upon the recommendation of the city council Mayor E. V. Babcock requested General George W. Goethals to come to Pittsburgh for the purpose of reviewing the situation. General Goethals did so on Nov. 20, and submitted the following report under date of Nov. 22:

Sir—In compliance with your request I submit herewith a report on the Bigelow Boulevard slide.

My information is based upon data in possession of the city engineer; upon statements made by him and the Director of Public Works; by inspection at the site, and from the history obtained from Mr. Ritchey, engineer in charge of removing the slide.

The original boulevard was constructed on a fill built across a ravine in the hills. During its construction the material slipping down endangered the Pennsylvania R.R. tracks at the foot of the slope and an injunction was secured

by the railroad company. The difficulty was overcome by the construction of a retaining wall. As the fill progressed additional precautions became necessary and a timber crib, probably filled with rock, was built higher up the slope to relieve the overcharge on the retaining wall. While some attempt was made to drain the fill and to carry off water that had access to the slope, the drawings exhibited show that it was not adequately accomplished, and this is confirmed by the consistency of a part of the material being removed by the steam shovels.

The saturated condition of the material due to lack of proper drainage, combined with overloading the bank, resulted in overcoming the resistance offered by the crib and retaining wall and caused the slide. While the additional load was undoubtedly the straw that broke the camel's back, I have no doubt from the fluidity of part of the mass that it was only a question of time when the slide would have occurred.

FIG. 4. AT THE NOSE OF THE SLIDE—SHOVELS WORKING ON TRACKS LAID ON UPHEAVED MATERIAL

There is nothing that now can be done to stop the movement; the only thing remaining is to dig out the material as it reaches the lower level. No satisfactory method can be devised or used to reduce the weight on top.

From Mr. Ritchey's records I agree with him that upheaving of the tracks at the foot of the slope is caused by the forward movement of the mass of the retaining wall which remains intact, shoving the material out ahead of it, similar in action to a plow. The present indications are that this upward movement will cease when the old retaining wall is removed.

It is difficult at this time to say what the exterior limits of the slide will be. All the material within the cracks that now appear on the ground will move and the bulk of it will have to be taken out. As the material moves out, allowing a settlement at the top, additional cracks may develop, and will then become the bounding lines for the slide or unstable area. I should not be surprised if it took in all of the material in the old ravine up to the retaining wall in rear of the stable.

As explained to the engineers a record ought to be kept of the movement as it progresses by levels taken on stakes scattered over the surface of the slide, from which indication can be obtained of what is likely to happen.

Efforts should be made to keep all the water possible from the slide area and none of it should be allowed to stand in pools on the surface if it can be carried off economically. Cold weather may to some extent retard the movement, unless water is kept off freezing is liable to produce additional difficulties.

The situation is serious from the railroad standpoint, also so from the highway standpoint. The engineers can proceed with their borings to determine the location and character of rock over all of the area except that which is in motion, and with the preparation of their plans based on the data obtained, so that there need be no delay in the preparation of the budget. The temporary roadway that is now built across the ravine should be watched carefully to guard it against undermining which may result from movement due to the breaking away of additional material. These movements as a rule are not precipitate and generally consist in the first instance of a settlement, so that no calamity to users of the boulevard is anticipated.

I learned of the output of the steam shovels prior to visiting the site at which they are working when it seemed that they were not securing efficient results. An examination of the locality along the railroad caused me to modify my views. The necessity of maintaining as many tracks open as practicable and the rapidity with which the earth is moving leads me to the conclusion that they are doing all that can be expected of them under the circumstances, and that the railroad engineers are justified in maintaining all the shovels at work in the positions where they were operating in respect to the slide. When the upheaving and consequent breaking up of the tracks have stopped a loading track can be maintained without interruption, a redistribution of the shovels will be practicable and some of them can be withdrawn.

Further study regarding the cause of the slide, the extent to which each of several possible factors contributed to it, and the methods to be adopted in order to prevent further difficulties will have to be postponed until after the immediate problems of earth removal and maintenance of traffic are out of the way and until the large amount of additional information now being collected by borings, surveys and other observations is available.

Information regarding the history of the original Boulevard construction has been furnished from records in his possession by Capt. James Wells, chief inspector for the city during the original construction of the Boulevard. Information regarding previous slides on the Pennsylvania system has been furnished by Robert Trimble, chief engineer of construction, and W. D. Wiggins, chief engineer of maintenance-of-way of the Central Region of the Pennsylvania R.R., and others. Photographs, survey data, plans and complete information regarding the work of dirt removal have been furnished by C. W. Ritchey, division engineer of the Pittsburgh Terminal Division, who is in complete charge of the work at the slide under the direction of Mr. Wiggins. N. S. Sprague, chief of the Bureau of Engineering of the Department of Public Works, is in charge of work being carried on by the city, under the direction of John Swan, Director of Public Works.

Surface Shrinkage of Rapid Filter Sand Beds

Further Discussion of Wolman-Powell Article—Hydraulics, Design and Operation Greater Factors Than Adsorption

By Weston Gavett
With Clyde Potts, Consulting Engineer, New York City

IN TWO instances of sand shrinkage cited by Abel Wolman and S. T. Powell in their article July 29, p. 210, *Engineering News-Record*, on "The Surface Shrinkage of Rapid Filter Sand Beds," fine sand was found in the beds. It is shown that laboratory experiments on samples of these and other sands demonstrated high adsorptive capacities. It is then shown that the adsorptive power and surface area, a measure of the fine material present, of the sands were interrelated. The observed data available on which an explanation of the sand shinkage in the two plants may be based are: (1) the presence of fine sand in both filters, (2) the demonstration that the adsorptive capacity of the sands was high by virtue of the fine material present.

Factors other than sand were not considered because in one case no shrinkage occurred until after the addition of a layer of unsuitable sand. It should be noted that the high adsorption in the two sands was due to the fine material present and aside from this accepted undesirable condition it is not shown that the sands differ from normal sands.

It is stated that the shrinkage was caused by a strong internal contracting force, presumably induced by adsorption. It is not shown that this force was not aided by the hydraulic conditions of the filter during operation. Had the filter been allowed to stand idle after washing with the sand in the fairly normal condition observed, additional data of value might have been obtained as to the velocity of the contraction phenomenon.

In developing their hypothesis, the authors point out that (1) the shrinking sands were adsorptive and plastic, (2) in clays, air shrinkage and plasticity vary with the [illegible] of colloids present, as measured by dye absorption (3) in various instances of "syneresis" underwater contraction is proportional to surface area, (4) in various arts and sciences the phenomena dealing with shrinkage plasticity, etc., have the one explanation—adsorption. In view of these facts the authors suggest that the malachite green test should give data of value on the action taking place in the filters. Their data also seem to show that a test for a sand of large surface area or containing a high percentage of fine material will give the same information.

It is shown that shrinkage in clay is produced by the addition of colloids. It is then the colloidal material naturally in the water or resulting from treatment that causes the shrinkage. The presence or absence of a colloidal organic film on the sand is not believed to affect shrinkage, the authors state. No doubt the adsorptive sand retains its colloidal coating during washing as it is difficult to conceive great contraction possible in a bed of clean sand of fairly uniform size when it has subsided after washing.

In giving the method of testing the sands for adsorption it is stated that the flask containing sand and dye was allowed to stand 24 hours after shaking to permit the fine material in the sand to settle. If the depth the material had to settle was say 5 cm. the velocity of settling would be about 0.00058 mm. per second, indicating a size of particle of 0.0009 mm. One pound of material of this size would have a surface area of around 12,500 sq.ft. This is rather fine material to include in a test for the adsorptive capacity of sands. A test on sands separated into particles of the same size would be of interest and would emphasize the high specific adsorption in the three sands mentioned, the coal filter material, the synthetic silicon dioxide and the Ottawa sand. No mention is made of shrinkage caused by any of these materials, and it seems yet to be proved that shrinkage would result from their use.

The writer has seen some instances of sand shrinkage in rapid sand filters. All seemed possible of explanation by causes other than those advanced by Wolman and Powell.

In one case a number of horizontal pressure filters were operated under a low head, practically as gravity filters. Large longitudinal cracks were always in evidence and were found immediately after washing and before the filter had been put in service. This case is not typical as it was no doubt caused by the circular cross-section of the filter and therefore not comparable to true sand shrinkage. Bacterial results from these filters were equal in quailty to those from open, vertical-sided filters with no side cracks, operated in parallel with the same water. This fact indicated that the crack was not opened suddenly during operation, but that a loss of head was built up on the sand surface of the crack allowing it to act as an effective part of the filter surface. Where the sand surface breaks or cracks at the sides or elsewhere it follows that a poor quality of effluent will result, the crack acting as an orifice in a relatively impervious surface.

In another instance the cementing of the sand caused the whole area of sand to rise when washing was commenced. This phenomenon in the case of Springfield is cited by the authors as an illustration of the internal contracting force in the filter sand. The writer noted the occurrence after the filters had been under a heavy load, and attributed it to an excessive amount of suspended matter removed from the water, combined with the pressure developed on the sand by the flow of water through it under high loss of head. The filter returned to its normal condition after the character of the water had changed. Mechanical agitation of the sand by hand raking during washing was found of value during the period of cementation.

Persistent contraction and side cracks were observed in another plant where the presence of fine sand may have been the contributing cause. It is believed that the filters were washed at too low a rate, which was limited to that at which no sand would be wasted. Under these conditions the presence of fine sand in the beds would result in a low wash-water rate being used and the fine sand would remain in the filters.

Other cases have been described to the writer, of filter beds breaking during operation when the character of the applied water appeared to be the causative factor. In one instance it was said that breaking occurred at a time when iron and lime were used on a water more amenable to treatment by alum. These cases suggest an opportunity for investigation along lines outlined by Wolman and Powell on the nature of the material removed by the filter. The theory might be advanced that

a plastic highly adsorptive matt would be superior to a more granular, less adsorptive coating in tending to resist breaking under the forces acting upon it.

In investigating sand shrinkage and other problems of filter performance, the science of hydraulics and the design and methods of operation of the filter should not be neglected. The following factors may have some bearing on the subject.

Air and Water Washing—Advocates of high-rate water washing claim that the use of air is not necessary. Operators using air point to long periods of good service and testify to its value. Perhaps we cannot say that water washing will be successful in all cases because it has worked in others, any more than we can predict that a coagulant efficient with one water will be equally successful with another supply. In one of the cases before mentioned water wash alone was sufficient at most times, but under certain conditions additional agitation by raking was of value.

Strainer Systems—A good strainer system is essential to a good filter. The double bottom system approaches the ideal condition. The writer has operated small filters

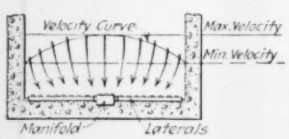


FIG. 1. CENTRAL MANIFOLD ACCENTUATES CENTER WASH-WATER RISE

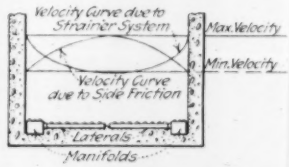


FIG. 2. SIDE MANIFOLD NEUTRALIZES WALL FRICTION

of this type and they leave nothing to be desired either from a mechanical or bacterial standpoint. It is claimed that manifold-and-lateral systems are as efficient as double bottoms, especially when water passages of large area are used. The writer has seen a manifold-and-lateral piping strainer system, that had been subject to an incrusting water, uncovered. Probably over half of the total orifice area had been completely sealed. The strainers near the inlet were clear. The incrustation increased with the distance from the inlet, and became a maximum at the further corners where the strainers were completely sealed. The action is progressive, starting at the point of least pressure and working back. Even in a filter with large passages it is conceivable that the velocity distribution during filtration and washing is not entirely uniform over the whole bed. Certainly with some strainer systems this is the case, the velocity curve having the form indicated in Fig. 1 with the direction of flow indicated by arrows. Under these conditions, if the filter contained fine sand would it not have a tendency to work towards the sides of the filter? Would the divergence from vertical flow lines suggested in Fig. 1 aid in contracting the sand away from the sides?

Assuming the velocity distribution from the strainer system is perfect, the friction on the sides of the filter will tend to reduce the velocity at this point. When the filter is washed and the sand is in suspension, we should expect the velocities to be lower at the sides than in the center, analogous to flow conditions in pipes. If the velocities are low at the sides due to the strainer system as well, the condition is aggravated. We may then expect to find, and do find, instances of poor washing at the sides of filters, with attendant evils of caked sand and dirt at that point. The thought suggests itself that if a manifold system must be used, it should be of advantage to place the manifolds at the sides to compensate somewhat for the reduction in velocity due to friction of the sides as indicated in Fig. 2.

If a filter is suspected of having a non-uniform distribution of pressure the fact may be readily ascertained experimentally, by testing the loss of head in different parts of the bed by the method used by James H. Fuertes in the Harrisburg negative-head case. The writer once used the following simple method for obtaining the loss of head through the sand while the filter was operating under a positive head. A piece of small pipe, long enough to extend to the desired depth in the sand and above the water surface in the filter, was placed in the desired position while the filter was being washed, and held until the subsiding sand gripped it firmly in place. The water level in the pipe was obtained by sounding with a small weight and cord. In this instance several pipes were located at the same part of the bed but at different depths. Measurements taken during a filter run showed that the increase in head was practically confined to the few inches at the top of the bed.

Rise of Sand During Washing—The writer does not altogether agree with Wolman and Powell that fine material in a filter will not be removed hydraulically by washing, provided that the filter is properly washed when the sand is clean. He once constructed a demonstration filter from a glass tube 2 or 3 in. in diameter with a copper wash-water trough at the top and a strainer set in a rubber stopper at the bottom, with connections and valves for wash water and filtered water. The sand and gravel were taken from the filter beds of the plant. This plaything was useful in showing the delicate relation between the rise of the sand and the vertical velocity of wash water. A slight change in the wash-water rate was indicated by the sand rise.

Tests on the rise of sand are described by Langdon Pearse in the *Engineering News-Record*, Mar. 18, 1916, p. 385, and the plotted relation between velocity and rise shown. In general the finer sand shows a greater rise with the same wash-water rate.

J. W. Ellms gives the results of a thorough investigation of the behavior of sands while washing, in the Proc. Am. Soc. C. E. Vol. LXXX, p. 1016, and shows the height of sand during washing to be affected by the depth of sand, its fineness and the velocity of wash water.

It does not seem that sand, greatly finer than the main bulk, would stay in a filter unless the sand were heavily coated, the rate of washing too low, the wash water trough much higher above the sand than necessary or the distribution of wash water poor.

Fine Sands in Filters—Aside from adsorption, fine sand may be harmful in other ways. No doubt most sands tend to accumulate a coating of colloidal matter, especially if the filter is not sufficiently washed. If the sand is relatively large and uniform in size this may not be harmful unless the coating is too thick and plastic. On fine sand the film may be a considerable percentage of the diameter of the particle and compression or shrinkage can be conceived when it is considered that

there may be several feet difference in head between the surface of the sand and a level a short distance below it.

To digress from the subject of sand, the work of Wolman and Powell suggests that the malachite green adsorption test may be an admirable means of obtaining a measure of the fineness of the suspended matter in the water. The writer has long sought such a test without results. The best solution seemed the use of the Tyndall cone, comparing the unknown water with prepared standards of different fineness. Unpublished experiments interrupted by the war indicated that the coefficient of fineness of the standard methods of the American Public Health Association is of little value except for a limited range of large particles. The malachite green test would seem to have possibilities for application as a fineness test, modified by the selective action or variable adsorptive power of different materials present.

Wolman and Powell have done a work of value in their careful study and presentation of data from many sources relative to the subject that might otherwise have remained buried, but further data are needed before it can be definitely stated that adsorptive power is objectionable rather than a quality to be desired in filter sand. If shrinkage occurs, the filter operator or engineer should not hasten to replace all his sand on the supposition that it is a highly adsorptive undesirable material until he has looked into other factors.

Old Air Drill Cuts Pavements for Los Angeles Water-Works

By C. W. Geiger
San Francisco, Cal.

FOR cutting through asphalt and concrete pavements in making excavations for water mains the Los Angeles Water Department uses an old air drill.

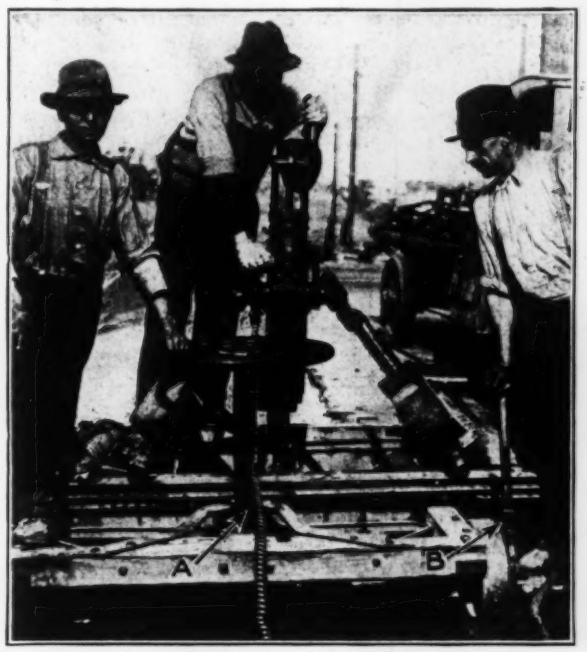
The drill is mounted on a carriage which in turn is mounted on a four-wheel truck. A handwheel attached to the truck is provided with a pinion which engages a rack on the carriage, by means of which the carriage can be moved sideways. This is shown at the point of the arrow marked "A" in the accompanying view. The carriage can be moved sideways so that a strip of pavement about 4 ft. wide can be cut. A ratchet working on one of the wheels of the truck moves the truck forward as the cutting progresses. This ratchet is shown at "B" in the view.

In actual operation, one man is required to start and stop the air drill, one operates the handwheel for the purpose of moving the drill sideways, and a third manipulates the ratchet for the purpose of moving the truck forward.

To cut through asphalt a sharp bit is used. The asphalt is cut through along the two sides of the strip, broken up and loaded onto a motor truck. The drill is then equipped with a blunt bit and the truck retraces the same path. The operator of the drill directs the bit against the surface of the concrete until the continuous pounding breaks it up for several inches in all directions. Then, without stopping the drill, the carriage is moved sideways several inches, and the pounding concentrated until this area is broken up. When the entire width is broken up the truck is moved forward and the carriage is moved to the opposite side of the strip, the drill being kept in operation while this is being done.

In one day this apparatus can cut through asphalt and break up a 4-ft. strip of concrete foundation for a distance of 120 ft. This has proven to be considerably cheaper and easier than the method usually employed for doing this kind of work. The cost of cutting through good pavement and concrete base varies from 2 to 5c. per square foot.

Compressed air is furnished by an air compressor mounted on a motor truck just back of the driver's seat. The truck is also equipped with a centrifugal pump, which is used principally in pumping water when



OLD AIR DRILL RIGGED UP TO CUT PAVEMENTS

there is a leak or break in a water main. It has a capacity of 900 gal. per minute. A small air pump, mounted on the water pump, is used to prime the latter. By means of special transmission gear, either the main air pump or the centrifugal pump can be operated by the 40-hp. motor that operates the truck.

The Los Angeles Water Department is planning to try steam power in place of compressed air to drive the apparatus. An air-driven pavement cutter and breaker, supplied by the local Ingersoll-Rand agency, is used by the Los Angeles street railways.

Germans Underbid Americans for Locomotives

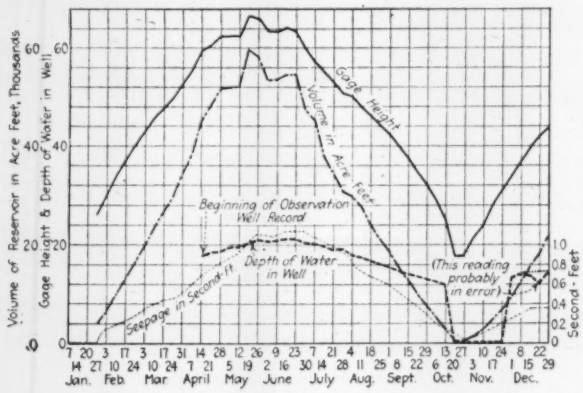
According to a statement in a recent issue of *The Engineer*, London, Krupps, of Germany, have underbid American locomotive manufacturers for electric locomotives for the Java State Rys. The contract was for eighty-three locomotives. It is suggested in the English paper that the depreciation of the mark may have enabled Krupps to put in the lower tender, but the fact that the German factory is able to take such a large contract at a reasonable price is particularly commented upon.

Improvements on a State Irrigation Project in Utah

Piute Earth Dam Strengthened with Porous Fill After Study of Seepage—Spillway Enlarged—Cylinder Gates—Diversion Dam on Gravel Foundation

By J. C. Ullrich
Deputy State Engineer, Salt Lake City, Utah

IMPROVEMENTS made and under way on the State controlled Piute irrigation project in Utah, in order to insure continuity of service to the water users, involve an expenditure of nearly $230,000. Investigations of seepage through an earth dam during a period of five years resulted in plans for strengthening the dam by a heavy non-impervious fill of sand and gravel placed on the downstream slope over a well-drained foundation. A comparatively small spillway was increased in capacity to care for three times the greatest flood of record and to take a flood which might be caused by the breaking of a dam above the Piute


Volume of Reservoir in Acre Feet, Thousands
Gage Height & Depth of Water in Well
Second-Feet
Gage Height
Volume in Acre-Feet
Beginning of Observation Well Record
Depth of Water in Well
(This reading probably in error)
Seepage in Second-Ft.
Jan. Feb Mar April May June July Aug. Sept. Oct. Nov. Dec.

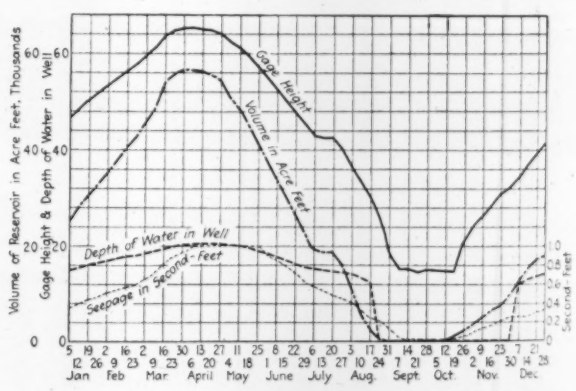
GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1917

structure. Experience with an air-slaking rock added much to the cost of the wasteway. To insure delivery of water should one set of gates break (as did happen) an auxiliary set of gates of the cylinder type is now being installed. A 6-ft. diversion weir had to be constructed on a porous foundation requiring special consideration.

This project, which was built by the State Board of Land Commissioners, was begun in 1908 and put into service in 1914. It comprises a storage unit of 90,000 acre-feet capacity and a canal system of 64 miles. The Piute reservoir storing winter and flood flows is located on the Sevier River about 12 miles above Marysvale. A concrete diversion dam 25 miles below the dam conveys the stored water through the canal system to 20,000 acres of land. The first 20 miles of the system is an enlargement of the Sevier Valley Irrigation Co.'s canal, from which practically no Piute project water is diverted. The remaining portion serves the acreage under the project, the land lying in a narrow strip along the upper west side of the Sevier Valley where 14,000 acres have already been brought under irrigation.

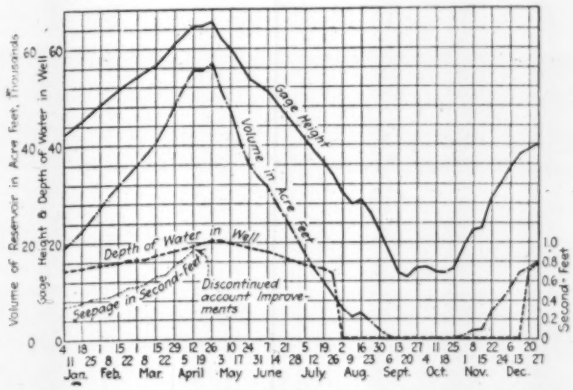
The reservoir dam, put into service in 1914, is a hydraulic fill structure 508 ft. long on top, 95 ft. high above stream bed with upstream and downstream slopes of 3 to 1 and 2 to 1 respectively. (See *Engineering Record*, July 17, 1915, p. 80.) A core trench was excavated to bedrock, 40 ft. below the bed of the stream, a concrete cut-off wall 4 ft. high being built on the rock and the trench re-filled to the original ground surface with clay puddle. (See *Engineering Record*, Nov. 8, 1913, p. 522.) An outlet tunnel 6 ft. wide by 8 ft. high was driven through the ledge rock forming the west abutment. This tunnel is equipped at its upper end with three 4 x 6-ft. cast-iron slide gates designed to operate under a maximum head of 80 ft.

Seepage Fluctuates.—Shortly after the dam was put into service, considerable seepage appeared at various places along the lower toe. At first it was thought that this seepage would decrease after the dam was in operation for a while and the slopes had a chance to silt up, but as time went on the seepage increased. While there was no evidence that the dam was being undermined or that the seepage was removing material from the body of the dam, the indication was considered of sufficient importance to warrant close study. In the spring of 1915, therefore, a drain ditch was constructed along the toe of the dam, the seepage water collected being passed over a V-notch weir and a daily record kept of the amount. It was soon discovered that the seepage fluctuated with the height of water in the reservoir and amounted to as much as 1.1 sec.-ft. when the water reached a height of 67 ft. In the fall of 1916, plans were prepared to sink a number of observation wells into the lower half of the dam to determine the line of saturation, but owing to a lack of funds for this work, only one well was sunk. It


Volume of Reservoir in Acre Feet, Thousands
Gage Height & Depth of Water in Well
Second-Feet
Gage Height
Volume in Acre Feet
Depth of Water in Well
Seepage in Second-Feet
Jan Feb Mar April May June July Aug. Sept. Oct. Nov. Dec.

GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1918

is located in the central part of the dam, two-fifths of the distance up from the downstream toe, and was constructed by sinking a shaft 4 ft. in diameter to a depth of 40 ft., bringing the bottom of the shaft to the original ground surface. In the center of this shaft was placed 40 ft. of 16-in. wood-stave pipe, the bottom 15 ft. of which was perforated spirally with ⅜-in. holes spaced 3 in. apart vertically. The well was then filled with selected material graded from coarse gravel around the pipe to sand around the periphery


Volume of Reservoir in Acre Feet, Thousands
Gage Height & Depth of Water in Well
Second-Feet
Gage Height
Volume in Acre Feet
Depth of Water in Well
Seepage in Second-feet
Discontinued account Improvements
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

GRAPH SHOWING WATER HEIGHTS IN WELL AND RESERVOIR, 1919

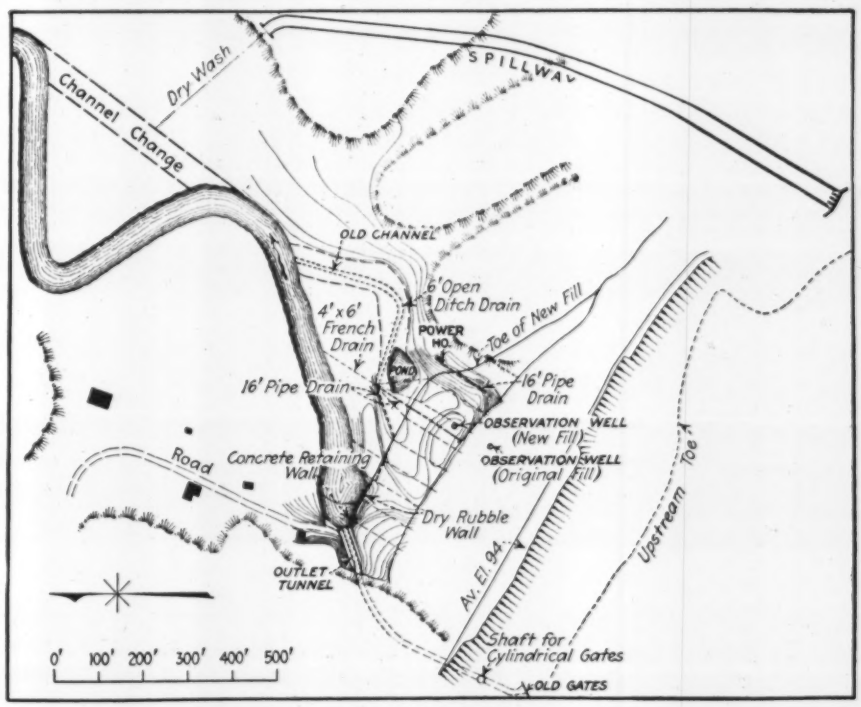
of the well. A record of the depth of water in the well was taken every week and plotted on a profile of the dam. By connecting the height of water in the reservoir with the depth of water in the well, an approximate idea of the line of saturation through this portion of the dam was obtained. While the line of saturation determined by these two points never intersected the downstream slope of the dam above the toe, there were times when the downstream face showed sweating to a height of 5 or 6 ft. above the toe, although no water was ever noticed actually oozing out of the fill.

Hydrographs for the years 1917, 1918 and 1919 show the relation between the height of water in the reservoir, the depth of water in the observation well, and the amount of seepage appearing at the lower toe. Taking equal increments of increase in the height of water in the reservoir the rate of increase of the seepage water is approximately in the ratio of 2 to 1. This ratio appears to hold equally well when the reservoir is being emptied. The diagrams also show a fairly well-defined lag between the increase and decrease of the water in the reservoir and the increase and decrease in the amount of seepage.

The curves representing the depth of water in the observation well also show a direct relation between the water in the well and the height of water in the reservoir. They show, however, that no water appears in the observation well until the water in the reservoir reaches a height of approximately 30 ft., when the water in the well suddenly rises to a depth of 12 ft. (records were taken once a week) and then continued to rise and fall as the water in the reservoir rises and falls. The fact that the water suddenly appears to a depth of 12 ft. in the observation well, when the height of water in the reservoir reaches the 30-ft. stage, is a strong indication that there is a porous stratum extending through the dam or at least through a part of the dam in the immediate vicinity of the observation well. The hydrographs further show that for the same stage of the reservoir, for the several years over which records have been obtained, the depth of water in the observation well and the amount of seepage appearing at the lower toe of the dam are the same.

A study of these diagrams led to the conclusion that the seepage water appearing at the lower toe of the dam was the direct result of water percolating through the dam. While it was realized that the record of this one observation well disclosed the internal condition of the dam at only one section, nevertheless an earth dam is no stronger than its weakest spot. This condition, together with the fact that the downstream slope is entirely too steep for a dam of this size, was considered by both the state engineer and the Board of Land Commissioners to justify their taking immediate steps to strengthen the dam.

Strengthening the Dam.—The plan adopted provided for the placing of an 80,000-cu.yd. earth fill against the downstream side of the dam and the construction of a drainage system in the foundation for the new



IMPROVEMENTS ON PIUTE DAM

fill. This foundation covers an area of approximately 2.3 acres, the greater portion of which was wet and boggy. A system of French drains 50 ft. apart was constructed throughout the foundation at right angles to the dam. These drains intersect a small rock toe constructed at the lower toe of the old dam and discharge into the river below the toe of the new fill. They were constructed by excavating trenches 3 ft. wide and 3 ft. deep, on a grade of 2 per cent, filling them with a 2-ft. layer of cobble rock varying in size from 4 to 8 in., on top of which was placed a 6-in. layer of coarse gravel which in turn was covered with a 6-in. layer of pea gravel. The original plans contemplated only the installation of eight French drains,

but during construction the resident engineer installed several additional 16-in. wood-pipe drains surrounded with rock, at points where the saturation was the greatest. The pipe drains are connected with a 6-ft. open drain leading to the river. Old redwood pipe stored at the dam was used.

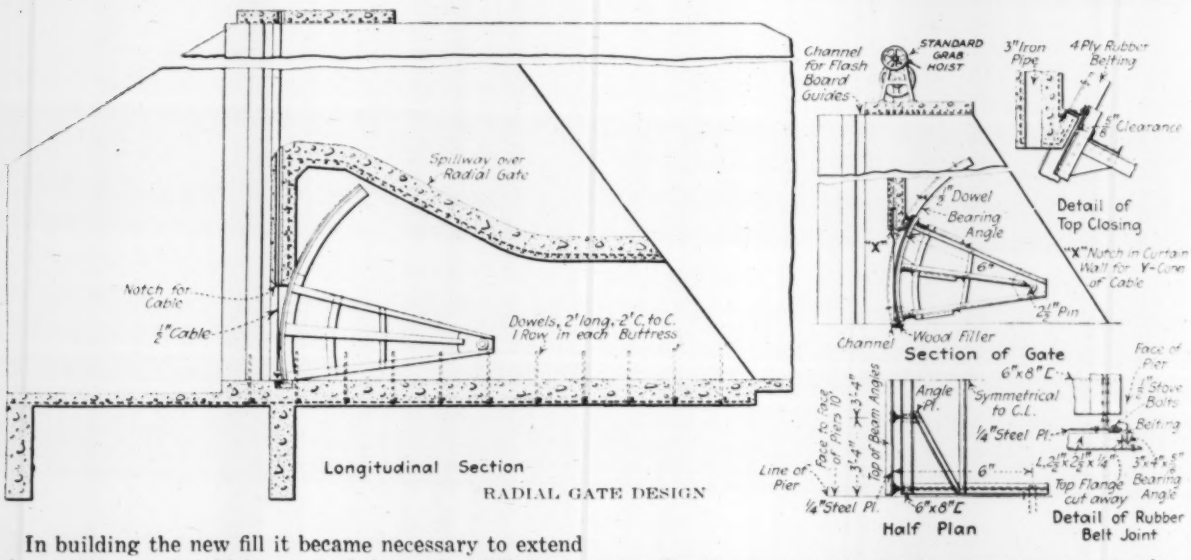
The purpose of the drains is two-fold (1) to dry up the foundation for the new fill; (2) to carry off all water that may seep through the old dam. Within a week after the drains were in operation they had dried up the foundation site so that the contractor could haul loaded 1½-yd. dump wagons over the foundation.

The cobble rock riprap which partially covered the downstream face of the dam was removed, and such rock as was not needed in the construction of the French drains and a riprap retaining wall at the mouth of the outlet tunnel, was placed in a 6- to 8-ft. wall at the toe of the new fill.

FILLING POROUS MATERIAL ON BACK OF DAM

months. The average length of haul was 500 ft.

A saturation well, similar to the one sunk into the old dam, was built into the new fill in line with the original well. Though this well has been under observation for the past two irrigation seasons no water has appeared in it, while during the same period water has risen in the original observation well to a maximum depth of 23 ft. The French drains are working perfectly and are keeping the new fill dry.



RADIAL GATE DESIGN

In building the new fill it became necessary to extend the outlet tunnel, which emerged from the cliff forming the west abutment of the dam at a point just below the lower toe. From this point the water was conveyed in a concrete flume 20 ft. wide to the river. Using this flume as a foundation the outlet tunnel was extended as a concrete section, having the same inside dimensions as the original tunnel, to the toe of the new fill. Dry rubble masonry walls on concrete foundations form the wing walls for the portal and protect the new fill against the action of the water flowing from the tunnel.

In preparing the foundation for the new fill, the soil to a depth of 1 ft. was removed and wasted and the surface roughened by plowing furrows 3 ft. apart. Steps were also cut in the downstream face of the old dam at intervals. No material of an impervious nature was allowed, nor was rolling or compacting required. The purpose of this loose fill was to insure a layer that would be pervious to the extent of allowing all water that might find its way through the old dam to filter down into the drains, thus keeping the new fill dry and firm. The new fill extends to within 20 ft. of the top of the dam, making this portion of the downstream face on a slope of 3¾ to 1. The fill was placed by means of a steam shovel and dump wagons in 4½

Spillway and Wasteway.—The original wasteway through a saddle east of the dam was 450 ft. long, 40 ft. wide, and was carried down 20 ft. below the top of the dam. From the wasteway the water was to pass down a natural draw to the river. As the wasteway was cut through a soft decomposed rhyolite, which air-slacks on exposure the cut became partially filled with talus after several years. No spillway or control device was constructed at the head of the wasteway. During this early period the water in the reservoir was never allowed to rise to the point where it would flow through the wasteway, but was regulated entirely by means of the outlet gates.

The improvements at the dam include completion of this wasteway and the construction of a spillway at its head. The channel was lowered 5 ft., extended 900 ft. and lined with concrete for the entire distance.

The spillway is a concrete structure consisting of piers with four ogee spillway sections between them and above four steel radial gates, the bottoms of the

gates being 10 ft. below the crests of the spillway sections. Concrete curtain walls extend from the spillway crests to the tops of the radial gates. The piers are 20 ft. high, 10 ft. apart and rest on a rock foundation. Each pier is equipped with stop-log slots faced with steel channels so that each gate opening may be closed if it becomes necessary to remove the gate for repairs while under water pressure.

Each of the radial gates is 4 x 10 ft. and operates on a 6-ft. radius. The gates consist of two truss bearing segments built of three ribs of 2½-in. x 2½-in. x ¼-in. angles crossed by three 6-in. channels which support 2½ x 2½ x ¼-in. angles bent to the required radius and having riveted to them a ½-in. faceplate. A ½-in. clearance is given between each end and the pier, these spaces being made water-tight by means of flexible membranes which are bolted to the ends of the gates and slide on steel-bearing angles bent to the same radius as the gates and set in the concrete piers. To insure the gates operating smoothly within this clearance, they were well braced laterally to prevent them from warping or racking. When closed the gates rest on wood filler blocks anchored to 6-in. channels concreted into the floor. Bearing pins are so arranged in the piers that they may be easily withdrawn, allowing the gates to be removed. One-man hoisting winches on top of the spillway operate the gates by means of wire cables.

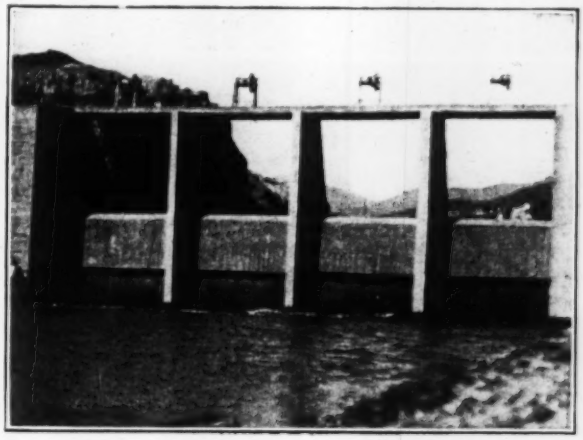
When the contract for the improvements on the spillway and wasteway was first let, it was deemed sufficient to line the wasteway for the first 450 ft. to a natural draw as it was thought that this draw was underlaid with a rock formation similar to that through which the cut was made. After the wasteway had been cut down to the lower elevation the bed of the draw was found to consist of sand and gravel to a considerable depth. It was then decided to extend the wasteway 900 ft. through the next ridge to a second natural draw. The entire wasteway is lined with 6 in. of reinforced concrete. The first 450 ft. is on a grade of 0.05 per cent with the concrete lining carried up the sides to a height of 10 ft. Beyond this point the grade was increased to 1.75 per cent, the section reduced to 20 ft. in width and the concrete lining extended up the sides to a height of 5 ft.

As the distance between the mouth of the wasteway and the river is 400 ft. and the difference in elevation is 25 ft., it is planned to construct a number of concrete cut-off walls to prevent scour in the bed of the draw.

A maximum discharge capacity of 10,000 sec.-ft. is provided in the spillway and wasteway for two reasons: (1) The Otter Creek reservoir which has a capacity of 50,000 acre-feet is located on the East Fork of the Sevier River about 25 miles above the Piute reservoir, and it was decided to provide sufficient capacity to take care of the flood that might result through the failure of the Otter Creek dam without danger of the Piute dam being overtopped; (2) the history of most earth-dam failures shows that the dams were overtopped during extreme flood stage due to insufficient spillway capacity.

As a rule floods which overtop dams are of an unprecedented nature, far greater than any of record. While the maximum flood flow of the Sevier River of which there is any record is 3,300 sec.-ft. it was deemed advisable to have a spillway of a capacity of at least three times this amount. Another feature that entered into the design of this spillway is the fact that at the present time reservoir right-of-way has been secured only up to the 70-ft. contour. To impound water above this elevation will cause it to back up into the town of Junction, located at the upper end of the reservoir. No arrangements have been made as yet to utilize the storage between the 70- and 80-ft. contours nor has the project developed to the stage where this additional storage is required. It was therefore deemed advisable to bring the bottom of the spillway to El. 70 so as to have absolute control of the water above that elevation.

Cylinder Auxiliary Gates.—Auxiliary outlet control

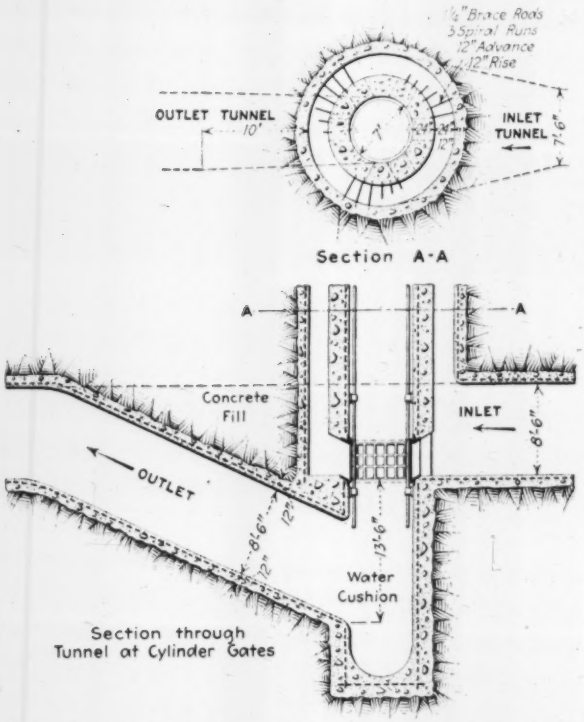


SPILLWAY WITH RADIAL GATES CLOSED

gates of the cylinder type are a feature of the improvements. It was considered that all dams impounding large quantities of water for irrigation purposes should be equipped with a dual outlet control so as to obviate the danger of loosing the stored water in case one set of gates becomes broken or disabled while in operation. This necessity at the Piute dam was illustrated forcibly several years ago when it was discovered that two of the three slide gates at the head of the outlet tunnel were cracked and a piece about 1 ft. square broken out of one of the gates. Had the gates broken during the irrigation season, releasing the water in the reservoir, it would have resulted in the loss of the season's crops valued at approximately $1,000,000. The gates were made of cast iron designed to operate under a maximum head of 80 ft. Cracking was due probably to excessive vibration. New cast-steel gates were placed and have been in operation since then.

A short tunnel was driven from the crest of the dam into the ledge rock to a point above the outlet tunnel, a shaft 17 ft. in diameter being then sunk to intersect the outlet tunnel 100 ft. back of the old gates. Within this shaft and concentric with it is an inner shaft formed by a reinforced-concrete cylinder 7 ft. inside diameter with walls 2 ft. thick, this cylinder being anchored to the outer shaft wall at intervals of 20 ft. with 6-in. I-beams. The outer shaft is lined with 12 in. of reinforced concrete. The annular space connects with the upper portion of the outlet tunnel while the inner shaft extends 15 ft. below the floor of the tunnel and connects with the lower portion of the outlet tunnel by means of an inclined shaft. The outlet tunnel immediately below the outer shaft is closed with a block of concrete 4 ft. thick.

In the inner shaft are set two steel cylinder gates, one at el. 0 and the other at el. 40, these gates fitting into cast-steel frames in the concrete cylinder. Each frame has six 2 x 3-ft. openings. The water entering the outlet tunnel rises in the outer shaft to the same height as the water in the reservoir. By raising the cylinder gates the water is admitted into the inner shaft, falls to the bottom and is forced up the incline shaft into the lower end of the outlet tunnel from which it flows without being under any appreciable hydraulic head. The cylinder gates when raised expose the same discharge opening for each intake. The



SECTION THROUGH TUNNEL AT LOWER CYLINDER GATES

intake openings in each gate frame are arranged in pairs diametrically opposite so that the water rushing through them has a tendency to balance the hydraulic pressure. The purpose of carrying the inner shaft 15 ft. below the floor of the tunnel is to provide a water cushion for the water falling down the shaft.

The gates are operated by means of specially designed man-power gate hoists set on a steel platform over the top of the shaft. Each gate is connected to a gate hoist by two 3-in. stems 180 deg. apart. These stems are kept in alignment by means of specially designed torsion guides anchored into the concrete cylinder. The upper gate will be used when the water in the reservoir is above el. 40 and the lower gate when the water is below this elevation.

In sinking the outer shaft the contractor first sank a hole 4 ft. square to the outlet tunnel. He then enlarged this hole to the dimensions of the outer shaft, allowing the material to fall down to the floor of the tunnel from whence it was mucked out in cars. The construction of this auxiliary control was begun in the winter of 1919-1920, but when the irrigation season began it had to be discontinued on account of the opening of the reservoir gates. The work is half complete and will be resumed as soon as the reservoir gates are closed for the 1921 season's storage. These cylinder gates will be used in operating the reservoir, leaving the slide gates at the head of the outlet tunnel for emergency use.

Diversion Dam.—The Sevier Valley Irrigation Co., years ago, built a rock and brush dam across the river at the head of its canal to act as a diverting structure. This structure was 110 ft. long, 15 ft. high and of very porous construction allowing fully 50 per cent of the water to pass through it. Furthermore, the dam would have to be partially replaced after almost every flood. One of the provisions in the agreement between the State and the company for the enlargement of the latter's canal was that the State should build a permanent diverting structure across the river at the head of the canal. The old diverting dam being located at a sharp bend in the river was in an unsuitable location for a permanent structure, so a more suitable site for a new dam was selected ½-mile upstream.

This new diversion dam is a concrete structure of the combination spillway and headgate type. The spillway is 87 ft. long, 6 ft. high, has an ogee section and rests on a sand and gravel foundation. It was designed according to the Bligh theory of weirs on porous foundations, using a value of 10 for *C*. On this basis with three concrete cut-off walls 4 ft. deep, an apron 25 ft. in length was required. The spillway section was so placed on this apron that 8 ft. of the apron extends upstream from the upstream face of the spillway. In addition a heavy riprap floor, cement grouted into place, was constructed across the entire river bed for a distance of 25 ft. from the downstream edge of the apron to prevent scour immediately below the apron.

The headgate portion of the structure is 48 ft. over all and contains four 4 x 10-ft. steel radial gates set between concrete piers with concrete curtain walls above the top of the gates. These gates are similar to those installed at the Piute dam. The piers are provided with stop-log slots so that any one of the gate openings may be closed to allow the removal of the gate for repairs. The headgate is set at an angle of 112 deg. with the spillway so as to draw water from the stream at right angles to the main current. As the Sevier River, especially during flood stages, carries considerable silt it was hoped by this arrangement to reduce to a minimum the amount of silt that might enter the canal. In addition, a sluiceway 4 ft. wide was constructed at the point where the spillway and headgate join. The sluiceway is kept open at all times, allowing a portion of the water, that must pass by the structure to satisfy prior rights below, to pass through the sluiceway.

The structure has been in operation now for the past two years. During this time it has been discovered that it operates best when a 12-in. stop log is placed across the bottom of each gate opening. There is less silt deposited in front of the gates and less enters the canal than when there is no obstruction in front of the gate openings.

Immediately below the spillway the river wound around in shape of a letter S within a distance of 2,000 ft. This portion of the river has been straightened by making a preliminary excavation sufficiently large to start the water down it. Forcing the water through this excavation made it cut its own channel.

The turnout gates installed in the canal at the time it was constructed were built of wood but these

are now being replaced with cast-iron turnout gates. The latter are designed with the face and frame supporting the operating stem on a slope of 45 degrees.

The cost of this improvement work was as follows:

Strengthening dam	$67,763.84
Spillway and wasteway	92,453.09
Auxiliary gates (estimated)	39,189.10
Diversion dam	17,569.14
Lateral turnout gates	12,581.00
	229,556.17

The entire improvement work on this project was under the direct supervision of George F. McGonagle, state engineer. E. S. Borgquist was the resident engineer directly in charge of the work at the dam. He also designed the structure for the cylinder gates. The plans for strengthening the dam and for the spillway, wasteway and diversion dam were designed by the writer. The cylinder gates were designed and furnished by the Lynch Construction Co., of Salt Lake City. The Heiselt Construction Co., of Salt Lake City, had the contracts for the improvement work at the dam. The diversion dam was constructed by force account with H. S. Kerr as engineer in charge.

Committees on Highway Maps and Co-ordination Present Reports

TWO reports, regarded as being of special importance, were submitted at a meeting of the Board of Surveys and Maps held in Washington, Oct. 12. One of the reports was from the Committee on Highway Maps and the other from the Committee on Co-ordination. In addition, the Committee on Hydrographic Charts called attention to the importance of the International Hydrographic Bureau which is now being established. According to the procedure of the board, committee reports are referred to the advisory council and copies are sent to each member of the board. In some cases it is expected that important changes will be made in the reports before they are accepted. The report of the Committee on Highway Maps supplements a previous report. The report is signed by C. D. Curtis and reads as follows:

1. The committee has considered the recommendations of the executive committee in commenting on its preliminary report to the effect that the surface condition of roads be indicated on the maps and has reached the conclusion that it would not be feasible to do this. This conclusion is based largely on the fact that with the present large program of highway improvement the maps would in many respects be out of date soon after being issued. In considering this matter the Chief of the Bureau of Public Roads was consulted and he concurs in this opinion. The question was also discussed with the members of the executive committee of the American Association of State Highway Officials. They were unanimously in favor of indicating the highways in accordance with a classification placing them into groups of equal or like importance.

The highways of France are divided into five principal classes. It is the belief of the committee, however, that four classes will adequately cover practically all of the highways in the United States. These four classes can be named as follows: National or Interstate, State, County, and Local; or Main through routes, important secondary routes, lateral or branch roads, and local roads. In isolated cases it might be found necessary to provide a fifth class which would include semi-private and private roads.

The matter of names given to the various classes of highways is relatively unimportant and the committee will be governed in its recommendations by the advice of the American Association of State Highway Officials.

2. In its preliminary report the committee expressed the belief that a quadrangle type map would most nearly meet the general need. We are now prepared to recommend a quadrangle map covering one degree in latitude by two degrees of longitude on a scale of 1:250,000, or approximately 4 mi. to the inch. This map to carry a 2-mi. overlap in each direction in order to provide for ready transfer from one sheet to another.

In sections where, owing to a multiplicity of roads, the 1:250,000 scale is not sufficiently large to prevent confusion, it is recommended that the scale be changed to 1:125,000 covering ½ deg. latitude by 1 deg. longitude with a 1-mi. overlap.

3. The committee does not wish to encroach on the work of the committee on technical standards but desires to suggest that a distinctive legend be chosen for each class of highway, that the width of highway be exaggerated, that the data shown on the topographic atlas sheets with the exception of isolated buildings be reproduced in so far as possible on the highway maps and that a tinted background be used. It will be necessary of course to eliminate many of the contours and the interval cannot be kept constant.

Co-ordination Committee Report

In reporting upon the proposition of co-ordination of all map-making agencies, the Committee on Co-ordination stated that the advantages to be secured at this time from such consolidation were purely problematical and the committee deemed it unwise to make such a radical recommendation under existing conditions. It pointed out that each map-making agency only supplied its bare need, and were consolidation of all map-making agencies secured it would be almost inevitable that subsequent decentralization of control would result. In other words, with all map-making agencies under a central control, the diversity of interest would lead to the establishment of practically the same independent agencies as now exist.

Consolidation of map-making agencies might be practical and desired later on, particularly should a general appropriation be made by Congress for the support and administration of the single map-making body. Under present conditions, each map-making agency spends so little of its entire appropriation upon map making that such money as it would be able to set aside for the administration of a central organization might not be adequate.

In view of such conditions the committee headed by C. O. Sherrill, therefore, made the following recommendations:

(1) That for the present, no general consolidation of the mapping activities of the various Federal organizations be advocated.

(2) That as recommended in the report of the conference of representatives of the Federal map-making organizations, the United States Coast and Geodetic Survey be charged with the execution of the precise and primary control of the area of the United States, and the United States Geological Survey be charged with the execution of the tertiary control and the topographic mapping.

(3) That every legitimate effort be made to secure such appropriations for these two organizations as will insure rapid progress in a mapping program which will meet the needs of the map using organizations of the government. This will soon result in an absolute cessation from topographic work by at least four of the nine Federal organizations now actually engaged in such work.

(4) That the Board of Surveys and Maps prepare specifications for surveying and mapping and urged that these be followed by such organizations as may properly continue to do such work.

(5) That the co-ordination committee be empowered to take such steps as may be proper to keep in touch with the mapping progress of the various Federal organizations

and arrange for the execution of the various projects and the fullest possible co-operation with other organizations. Personal contact with the officials in immediate charge of the various surveying and mapping activities will bring results more quickly and more satisfactorily than will formal action by the board. Considerable progress has already been made by the committee along these lines.

The committee reported that it believes there to be greater and more serious duplication in map compilation and map reproduction than in the actual carrying out of field operations. For the purposes of study and comparison the committee grouped Federal map-making organizations into three classes, the first being those whose principal function should be surveying and mapping and including The Coast and Geodetic Survey; Topographic Branch, Geological Survey; Surveying Service, General Land Office; International Boundary Commission; Lake Survey, and Hydrographic Office. The various services which the committee named as possessing surveying and mapping as an incidental function included the Corps of Engineers, Forest Service, Bureau of Soils, Reclamation Service, Bureau of Indian Affairs, and the Mississippi River Commission. As map compilers it cited the Topographic Branch, Post Office Department; Bureau of Public Roads; and the Military Intelligence Division, General Staff.

Changes in St. Paul City Charter To Facilitate Paving

THE adoption by popular vote of two amendments to the city charter of St. Paul, Minn., designed to facilitate pavement construction by (1) limiting assessments for benefits to abutting property to a strip 12 ft. wide (on either side of the street) and by (2) allowing the use of wheelage taxes for paving, repaving and repairing streets, was noted briefly in our news pages Nov. 11, p. 961. The two amendments, each being an addition to Section 235 of the charter, follow:

Provided further, that the amount which may be assessed against abutting property for paving any street, boulevard, parkway, or other highway shall not exceed the cost of a strip of such pavement 12 ft. wide adjacent to the property thus assessed. The cost of the pavement, over and above the amount assessed against all property benefited, shall be paid out of city revenue or from money raised by bond issue or both. Where a permanent pavement has once been laid and paid for, in whole or in part, by special assessment such benefited property shall not again, for a period of fifteen years, be assessed for repavement or for repairing pavement.

Provided further, that nothing herein shall prevent the council from appropriating such sums as it deems advisable, from the moneys collected as the license fee on vehicles for the use of the streets, toward defraying the cost of repairing paved streets and the cost of new paving or repaving of streets and boulevards, and expenditures made from the proceeds of said license fee on vehicles shall not be considered as part of the cost of government as such cost is limited and defined by Section 201 of the charter.

Prior to these amendments the charter provided that all paving in St. Paul must be paid for by the property benefited, but in cases of property of low value the council had authority to order the cost of paving street intersections to be met by the general fund of the city. We are informed by George H. Herrold, managing director of the city Planning Board of St. Paul, that the Assessment Bureau never has assessed paving benefits for the street paved upon any property back of the center of the block.

Cement Plaster Lining for Wood Irrigation Flumes

Experience on Three Flumes Aggregating 1,560 Feet Indicates Success at Cheaper Cost Than All-Wood Flume

By Everett N. Bryan
Chief Engineer, Waterford Irrigation District, Waterford, Cal.

THREE flumes in the distributing system of the Waterford Irrigation District, Waterford, Cal., have been constructed with box siding and flooring of 1-in. No. 2 Oregon pine lumber to which was applied a 1-in. cement plaster lining in order to secure watertightness. The success which has attended the application of this type of construction to flume building warrants a description, together with notes on the experience of some earlier instances of similar construction by other parties.

As an experiment the Modesto Irrigation District, Modesto, Cal., in 1908 lined 50 ft. of an old wooden flume 5 ft. deep and 12 ft. wide across Dry Creek with 1 in. of cement plaster applied on a ⅜-in. galvanized plain wire mesh tacked to the wooden floor and sides. The box was made of 2-in. select, surfaced redwood. Owing to age the flume had decayed until it was difficult and very expensive to calk sufficiently to prevent excessive leakage. In an attempt to prevent excessive leakage the experiment was entirely successful but the treatment was not extended to the remainder of this flume nor to other flumes of the system because both the flume box skeletons and the substructures were badly decayed and the flumes were not designed with sufficient capacity. Locally the use of this method for patching old flumes has been employed and some short flumes of small cross-section were designed and constructed after this fashion.

In 1913 T. K. Beard, general contractor, lined an elevated tank at Cooperstown, Cal., with cement plaster for the storage of crude oil. The tank had a base 15 ft. square, a depth of 5 ft. 8 in., and a capacity of 9,500 gal. In this case a ¾-in. lining was applied in two coats to expanded metal lath tacked to 1-in. rough board siding. There has been no occasion to use this tank recently but it served its purpose satisfactorily when needed. A recent examination showed it to contain a 12-in. depth of crude oil and rainwater. Above this mixture the sun and rain had thoroughly cleansed the sides so as to admit close inspection. Only fine hair cracks appeared.

The success of these local experiments led to the consideration of this type of construction by the Waterford Irrigation District for three of its larger flumes. Comparative estimates made of metal, wood and plaster-lined flumes indicated that the latter could be built at least first cost. It was also believed that the plaster-lined flume would have a longer life and a much less annual maintenance cost than the plain wooden flume.

In the winter of 1916-17 the first experiment was made on a flume 900 ft. long 6 ft. 4 in. wide and 4 ft. deep. Bents, stringers and box skeleton were of "merchantable grade" Oregon pine. The box siding and flooring were of No. 2 Oregon pine, 1 in. in thickness. A ⅜-in. wire mesh of No. 20 gage, with "V"-shaped metal ribs attached transversely 8 in. c. to c. was first tacked securely to the inside of the box. The

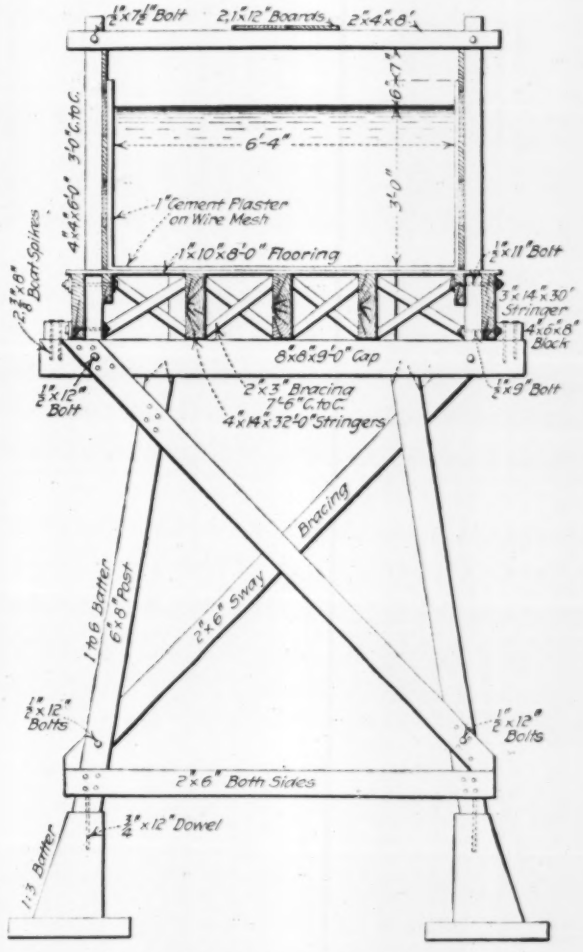
metal ribs held the mesh out approximately ⅜ in. from the lumber siding and the scratch coat of plaster was made just thick enough to cover the mesh. The second coat brought the thickness up to the required minimum of 1 in. The plaster was composed of one part cement, three parts sand, and dry hydrated lime equivalent by weight to 10 per cent of the cement.

Attention is directed in the drawing to the absence of cross-sills for the floor, the box flooring being laid crosswise and nailed directly to the stringers. It will be noted that the side posts of the box are bolted to the inner side of the outside stringers and no braces are used to prevent them from spreading at the bottom when the box is filled with water. They are held at the bottom solely by the outside stringers, which are themselves tied together by the nails in the ends of the floor boards and further stiffened by toe blocks on top of the bent caps and 4 x 6-in. cross-ties dapped and spiked to the bottom of the stringers half way between bents. So great was the rigidity thus secured for the side posts that even before the siding was nailed on or the top cross-ties were in place, the posts would break off above the floor, if sufficient pressure were exerted near the top, without in any manner displacing the base. Bents were usually low and it was pressure of the top of the post against the side grain in the cap rather than stresses as a column which governed the design of the posts. Mudsills were entirely eliminated by placing the base of the posts directly upon a concrete footing, thus eliminating another frequent point of initial failure for wooden bents.

Expansion Joints

It was not possible to place this flume in actual service during the irrigation season of 1917, but as a test bulkheads were built at the lower end and at the middle to permit filling by pumping soon after completion. Some fine cracks showed in the lining but the leakage was negligible and it was decided to build two more flumes of the same type. Plans were drawn and the flumes were constructed during the following winter, one being 330 ft. long, 5 ft. wide and 3½ ft. deep and the other 330 ft. long, 7½ ft. wide and 4 ft. 10 in. deep.

No expansion and contraction joints were provided in the first flume built and in a few months it had separated from the headwalls at each end, leaving a crack almost ⅜ in. in width. A home-made expansion joint was developed and installed at each end. Joints of a similar design were built into the two new flumes at the time of their erection. The joints consisted of a 14-gage galvanized-iron tongue bolted to the concrete headworks and projected beneath the plaster lining on the sides and bottom, where it was enveloped by a slot which was a narrow strip of 20-gage iron bent back upon itself. The tension of the slot upon the tongue was regulated by bolts at intervals—the tongue being split at these points to admit of its free movement to and fro. The workmanship upon these joints was crude, and while their operation has met with a fair degree of success it is believed something more positive in its operation should be recommended. The gap between the headwalls and the plaster lining has widened on the first flume since the joints were put in and on the two later flumes it is plain that had no joint been provided there would have occurred a similar rupture at each end of the lining. As it is, the tongue has simply been withdrawn from the slot. There is some movement both ways at these joints but the principal movement is due to shrinkage of the flume box in length.



TYPICAL BENT OF PLASTERED FLUME

There are no longitudinal cracks of any consequence in any of the flumes—the only tendency to crack seeming to be in almost straight transverse lines over the "V" ribs of the mesh, where the cross-sectional area of the plaster is diminished by approximately one half. In some places traces of these cracks may be detected over almost every rib for a short distance but it has been found easy to close all of them on the short flumes, and all those near the ends of the long flume, by painting the interior of the flume boxes with hot asphalt. The middle third of the length of the long flume, however, contains some transverse cracks up to ⅛ or 3/32 in. in width which cannot be closed by the asphalt coat. Apparently there is movement at these points too great for the asphaltic film to withstand. The absence of cracks in the oil tank described above and their character in the flumes would seem to indicate that expansion joints should be placed not farther than from 300 to 400 ft. apart.

The coating of asphalt applied required approximately 125 lb. per 1,000 sq.ft. A crew of three men put on 12,000 sq.ft. in three days. At first an attempt was made to brush the asphalt on with ordinary house brooms

but the results so obtained were not satisfactory. The best method was to apply the paint to the sides with paint or whitewash brushes and to the bottom with an ordinary floor mop.

On the first flume common labor was paid an average of $2.75 per day, carpenters and helpers from $3.50 to $4.50 per day and the plasterer $4 and $4.50 per day. The work was carried out under contract with Gorrill Brothers, contractors, San Francisco. Unit costs were as follows:

Cost of Woodwork per 1,000 ft. b.m.	
Lumber delivered	$25.44
Nails, bolts, washers, etc	3.66
Labor erecting	11.30
Total	$40.40
Cost of Plaster Lining, per Square Yard, Cents	
Mesh delivered	25.4
Laying mesh	6.1
Labor and tools applying mesh	14.0
Watering and curing	3.3
Cement, lime and sand	18.4
Total cost per square yard, cents	67.2
Total cost per 1,000 sq.ft.	$74.65

The No. 2 grade of Oregon pine used for box siding and flooring cost $20.50 per 1,000 ft. b.m. delivered. It was ordered to length so that no cutting was required for the siding and only one cut was required for each two floor boards. No effort was made to secure a close fit of these boards—in fact for the later two flumes it was specified that cracks of ½ in. should be left between them to prevent bulging when the boards became wet. Common labor was used mostly in putting the box together and, though no separate costs were kept of this part of the work, it went together quickly at a cost which may be safely assumed at less than $5 per 1,000 ft. board measure.

The cost of the flume box was therefore very close to $100 per 1,000 ft. of surface. Had it been built entirely of wood it would have been advisable to use 2-in. select cedar or redwood. To compete in first cost with the plaster-lined flume this wooden box would have to cost less than $50 per thousand feet board measure including battening and calking. Such lumber was at the time worth considerably more than that in the yard.

The annual maintenance cost, as was anticipated, has proved lower than for a wooden box flume, the recalking and reasphalting of which is necessary each time the water is out for a short time. It has been found that no matter how long the water is out of the plaster-lined flume it may be safely turned back without extensive repairs.

Coatings Reduce Bond Strength of Steel

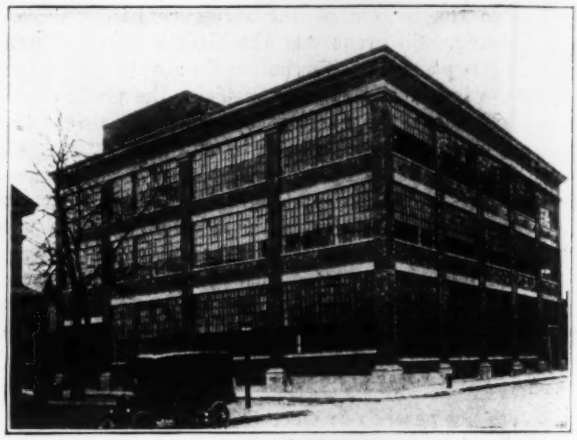
Results obtained in a special series of tests of bond strength of steel embedded in concrete are reported by the Bureau of Standards as follows: Galvanizing reduces the bond strength, but painting reduces it considerably more. Any coating allows a noticeable amount of slip in the case of deformed bars before the corrugations or lugs reach a firm bearing, but when they come to bearing the bars act substantially as do uncoated bars of the same form. However, coated bars develop a smaller fraction of their maximum bond strength in attaining a slip limit of 0.001 in. than do uncoated bars. Lap splices require a lap length of about 48 diameters to give a satisfactory splice; this result was reached with ½-in. bars embedded in unusually strong concrete (5,000 lb. per square inch).

Engineering Details of Newspaper Publishing Building

Mechanical and Business Needs Govern Layout and Structural Design of New Springfield "Republican" Plant

By Charles F. Dingman
Engineer, Flynt Building & Construction Co., Palmer, Mass.

When competition between rival newspapers for circulation becomes very keen, the saving of even a few minutes in the time of getting the papers on the street assumes a commanding importance. In fact, this saving of time is so vital that it becomes the dominating feature of the layout when the construction of a new publishing plant is undertaken. In the design of the new plant for the Springfield, Mass., *Republican*, described by the owners as "the last word in practical newspaper housing," every portion of the entire plant layout, as well as the structural design of the building, was governed by the dominant idea that the papers must be on the street in the least possible number of minutes. This condition was responsible for a rather unusual column spacing and also made it impossible to use any of the standard types of column caps or pintles for most of the locations.



NEW BUILDING FOR THE SPRINGFIELD *REPUBLICAN*
Note irregular column spacing and large window space.

The building is of modified mill construction, a basement and three stories in height, and occupies the entire area of a plot practically 100 ft. square at the northeast corner of Cypress and Boylston Sts. Since the location is off of the principal business street of the city, architectural attractiveness was not permitted to exert as strong an influence on the exterior design as did considerations of utility and economy, but it is felt that the final appearance is entirely satisfactory.

The basement, which is rather deeper than usual (11 ft. 11 in.), houses the heating plant, fuel storage, ink storage, transformer vault, print paper storage and a fireproof vault which will contain a complete file of the *Republican* since its establishment in 1824.

The first floor contains the press-room, the second floor the offices. The composing and stereotyping departments, as well as the staff photographer's laboratory are on the third floor. This arrangement of departments is part of the general plan to secure the most efficient production and quickest delivery.

All of the editorial work is done in the offices on the

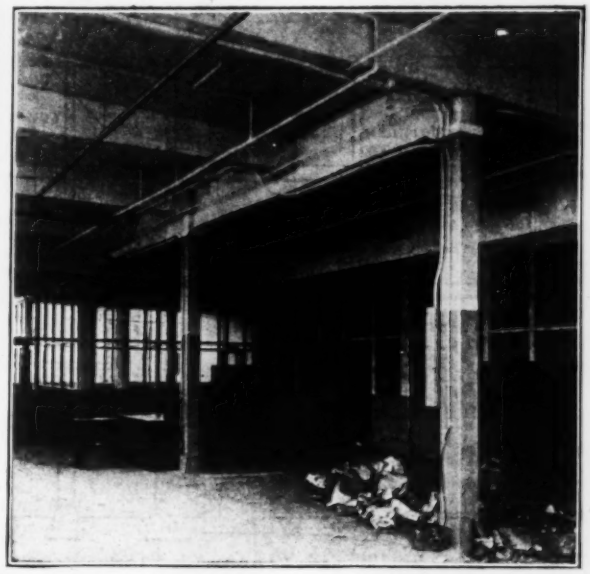
second floor, the rooms of the various editorial and reportorial departments being arranged along the west and north walls of the building, the business offices along the front or south wall and the stairway, toilet rooms, emergency hospital, etc., along the east wall. The window arrangement, as will be seen from the pictures, provides for the utilization of the maximum of natural daylighting.

In the center of the hollow square formed by the offices is the reference library, located there to provide easy access for any of the staff who have use for it. It is lighted partly by a light shaft extending through the third story to a skylight in the roof and partly by borrowed light through the glass partitions which surround it.

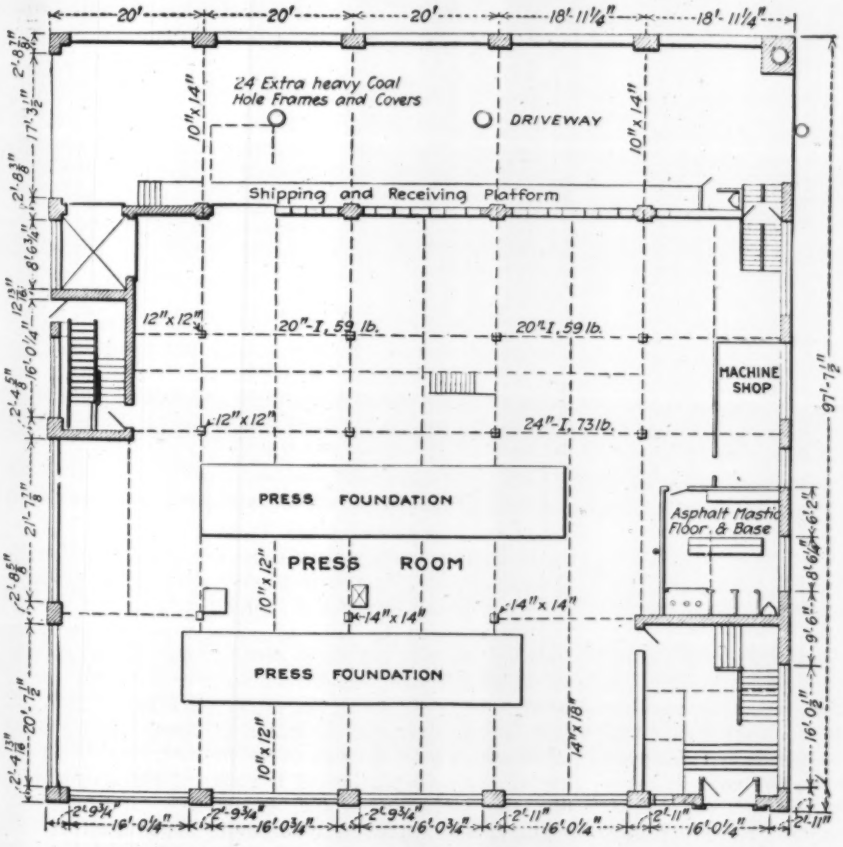
Communication between the editorial departments and the composing room is by means of a spiral iron stairway at the head of which is the proof-readers' office. The third floor was chosen for the composing room because it was possible to provide, by four rows of sawtooth skylights in addition to the large side wall sash, for the maximum amount of daylighting in every part of the room.

Directly adjoining the composing room is the stereotyping room, which presented a peculiar problem aside from the fact that it is the portion of the building carrying the highest unit live floor load. The equipment of the room includes a gas fired melting pot and an auto-plate casting machine, the latter being equipped with water jets for cooling the plates.

This equipment made it necessary that the floor should be waterproofed and also protected against the high heat (about 700 deg. F.) under the melting pot. At first it was thought that it might be advisable to install a concrete slab floor in the section occupied by the stereotyping room but, inasmuch as the remainder of the building was of mill construction and the columns were of wood, this idea was abandoned and the plank were covered with ¼-in. steel plates, having waterproofed joints, and a platform of ½-in. asbestos wood sheets was installed under the melting pot.



INTERIOR VIEW SECOND FLOOR SHOWING COLUMN CAP DETAILS

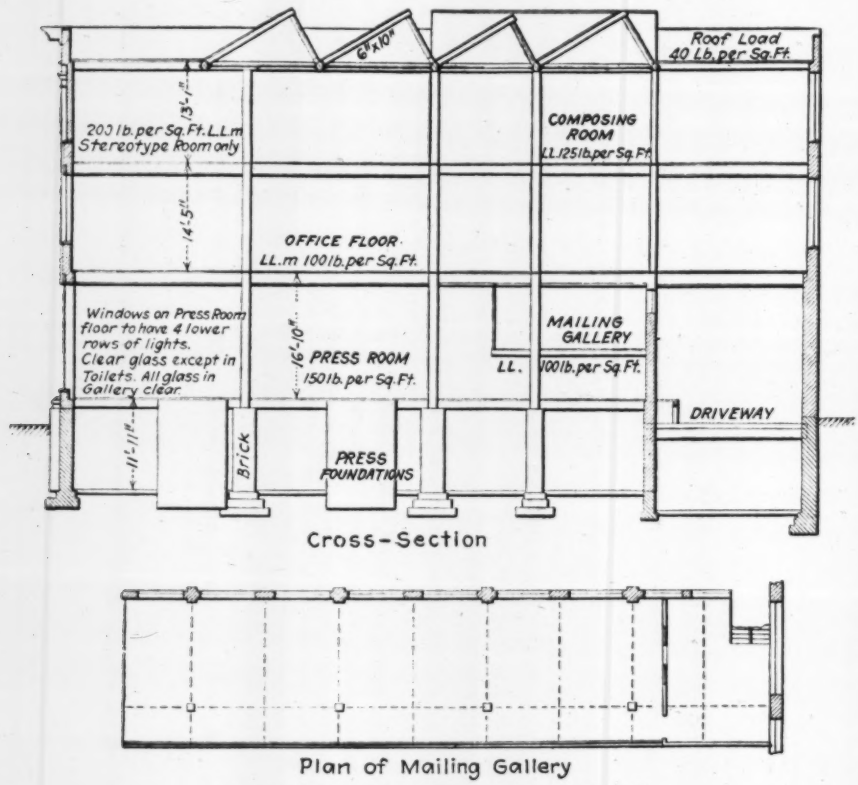


FLOOR LAYOUT OF FIRST FLOOR OF SPRINGFIELD *REPUBLICAN* NEWSPAPER PLANT

The stereotype plates are conveyed from the stereotyping room to the press room on the first floor by means of a Miles plate drop, which also returns them to the stereotyping room for remelting.

In designing the press room consideration was taken of the interest which printing presses in action always have for the public, so, even though the plant is not on the principal street, the sills on the front of the building were kept down close to the floor in order to permit people standing on the sidewalk to watch the presses.

The press room layout was really the dominant factor in determining the column spacing. In order to place the two presses, which are of the Hoe multiple web type having a combined capacity of 60,000 complete 32-pp. papers per hour, side by side and parallel to the front of the building, and at the same time provide necessary clearances for re-



(2) ELEVATION OF *REPUBLICAN* BUILDING

moving rollers and other work around the presses, it was necessary to make the two front bays each 23 ft. wide and the driveway at the rear necessitated a 20-ft. bay there, leaving only 28 ft., too much for one bay and too little for two full bays so, while the interior columns divide the span into two bays, a compromise was effected which resulted in the rather unusual pilaster spacing shown in the picture of the Boylston St. elevation.

This irregular spacing of the columns from front to back (they are evenly spaced in the other direction) resulted in having the horizontal members which meet at the columns of greatly varying depths. To have developed a satisfactory column cap with a bracket for each member would have been very difficult and certainly very expensive. Therefore, an ordinary cast-iron bracket cap is used to support the members whose soffits join the column at the lowest level and to serve as a base for the column above, no pintles being used. The other horizontal members are then carried on angles, the vertical leg of which is gained into the column and retained by lag screws, and the load is transmitted down to the column cap by pieces of steel channel which are fitted tightly between the underside of the angle and the top of the cap and held against the column by screws. Douglas fir timber and floor plank were used throughout.

The presses are supported on brick foundation walls resting on independent concrete footings below the cellar floor level and the pits formed by the press foundation walls contain steam radiation coils to maintain a temperature that will permit of satisfactory operation even in the coldest weather. The presses are electrically operated with Cutler-Hammer full automatic control, the control mechanism being located on a gallery adjoining the entrance to the press room.

As the finished papers come off the presses they are carried by automatic conveyors directly to the mailing room. This is located on a mezzanine gallery over the rear portion of the press room. Those papers which will be sold to local newsboys are passed to the east end of the mailing gallery where a carriers' room has been provided. Communication between the driveway and the carriers' room is by means of an iron stairway with a screen partition dividing it into two parts. The newsboys go up one side of the partition, pass the delivery window and receive their papers and thence down the other side and out without loss of time.

The other papers, which go out by mail or otherwise, are sorted and bundled and dropped on to sheet metal chutes which deliver them to the platform in the driveway below. This driveway, which is really a part of the building itself, extends through the rear section of the first floor and permits ten automobiles to receive their loads at one time and to pass on through without any turning around. There is no confusion in loading as the papers are sorted above and each truck simply backs up to the section of the platform assigned to it and receives its assignments through the chute.

This same driveway is used, outside of edition times, for receiving fuel and print paper, the coal hole openings being placed in the driveway directly over the bins so that no handling is required.

The mechanical layout of the plant is the work of Sherman H. Bowle, general manager of the Republican Co., while the building itself is the work of the Flynt Building and Construction Co. of Palmer, Mass., and New York City, the writer being the engineer in charge and B. L. Dow, superintendent of construction.

Small Warships Lengthened for Peace Service

Convoy and patrol boats built during the war by Great Britain have recently been lengthened to make them adaptable for use in merchant service. As built for the war they were 170 ft. long, and they have now been lengthened to 213½ ft. The work was done in some instances in dry dock, in others on launching ways, up which a vessel was hauled on a cradle. No special difficulties were met in the work. In addition to transforming the hull, the operation of change to merchant service involved reduction of the boiler capacity, rebuilding of the bow portion of the ship (originally shaped like the stern in profile, to deceive an approching enemy), and extensive changes in superstructure, etc. As rebuilt, the ships are of about 1,600 tons displacement and have a normal speed of 10 knots.

The Illinois State Waterway for Barge Navigation

First Contracts for 8-Ft. Channel from Chicago Drainage Canal to Illinois River—Large Locks for Boat Fleets—Flood, Ice and Water Power Plans

A NAVIGABLE connection between the Great Lakes and the Mississippi River, which has been the subject of several projects and considerable controversy during recent years, appears likely to become an accomplished fact within a few years, as the U. S. Government has approved the plans of the State of Illinois for an 8-ft. waterway and the State has awarded the contract for one lock and is inviting bids on other work. A plan and profile of the waterway are shown on pg. 1097.

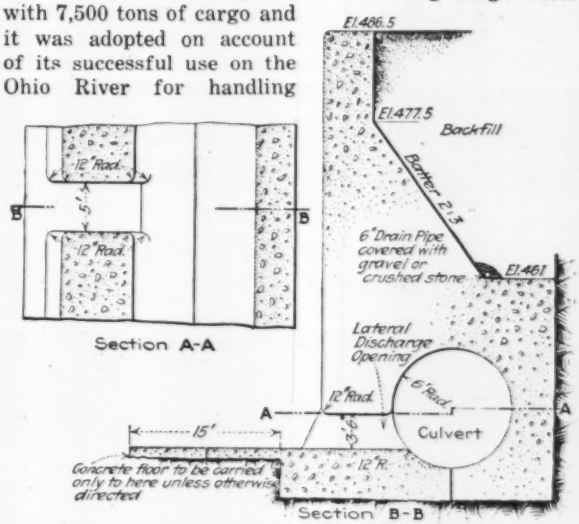
This State project includes canal construction and river improvement from Lockport, at the end of the Chicago drainage canal, to LaSalle on the Illinois River, beyond which point there is an 8-ft. channel in the river. The distance is about 60 miles, with a difference in water elevation of about 123 ft., this difference being provided for by five locks of 41 to 16 ft. lift.

History.—At this stage of development a brief historical review of the project is appropriate. A channel for navigation across the 7-ft. divide between the Chicago River and the Desplaines River has been proposed at various times since the first suggestion by Marquette, the explorer, in 1674. In 1829, the State of Illinois authorized the construction of the Illinois and Michigan canal from the Chicago River to the Illinois River at LaSalle. This was completed in 1848, giving a 6-ft. channel with fifteen locks 18 x 110 ft. Below LaSalle, the State built dams with locks at Henry and at Copperas Creek, in 1872 and 1877 respectively, to give a 7-ft. channel.

In 1883, surveys were made by the U. S. Engineers for extending the 7-ft. channel from LaSalle eastward to Joliet. In 1888, Congress ordered a survey for a 14-ft. waterway 160 ft. wide between Lake Michigan and the Mississippi River. Capt. W. L. Marshall, Corps of Engineers, U. S. Army, reported on alternative projects for 14-ft. and 8-ft. of water, recommending the latter as adequate and preferable. In 1899 and 1903, the U. S. Government built dams in the lower Illinois River at LaGrange and Kampsville, with locks 75 x 350-ft., thus extending the 7-ft. channel to the Mississippi River. In 1904, a board of engineers headed by Col. Ernst reported adversely on a project for a 14-ft. waterway from Lockport to the Mississippi with 80 x 600-ft. locks. Since that time nothing further has been done by the Federal Government. With the opening of the Chicago drainage canal in 1900, the lake-level channel was available as far as Lockport, at which point a lock connection was made later with the old 6-ft. canal.

The waterway project was taken up again by the State of Illinois in 1908, when the people authorized a bond issue of $20,000,000 for a navigable waterway from Lockport to the Illinois River at Utica, and passed an amendment to the State constitution permitting the expenditure of funds for water power purposes. Several plans were submitted, including one for a 24-ft. channel for lake and ocean steamers, but a State board of engineers reported adversely to both 24-ft. and 14-ft. channels. In 1915, the State legislature passed a waterway act and appropriated $5,000,000 for an 8-ft. waterway with 45 x 250-ft. locks, but the Federal government refused to grant the permit necessary for work in the Illinois River and nothing was done to carry the project into effect.

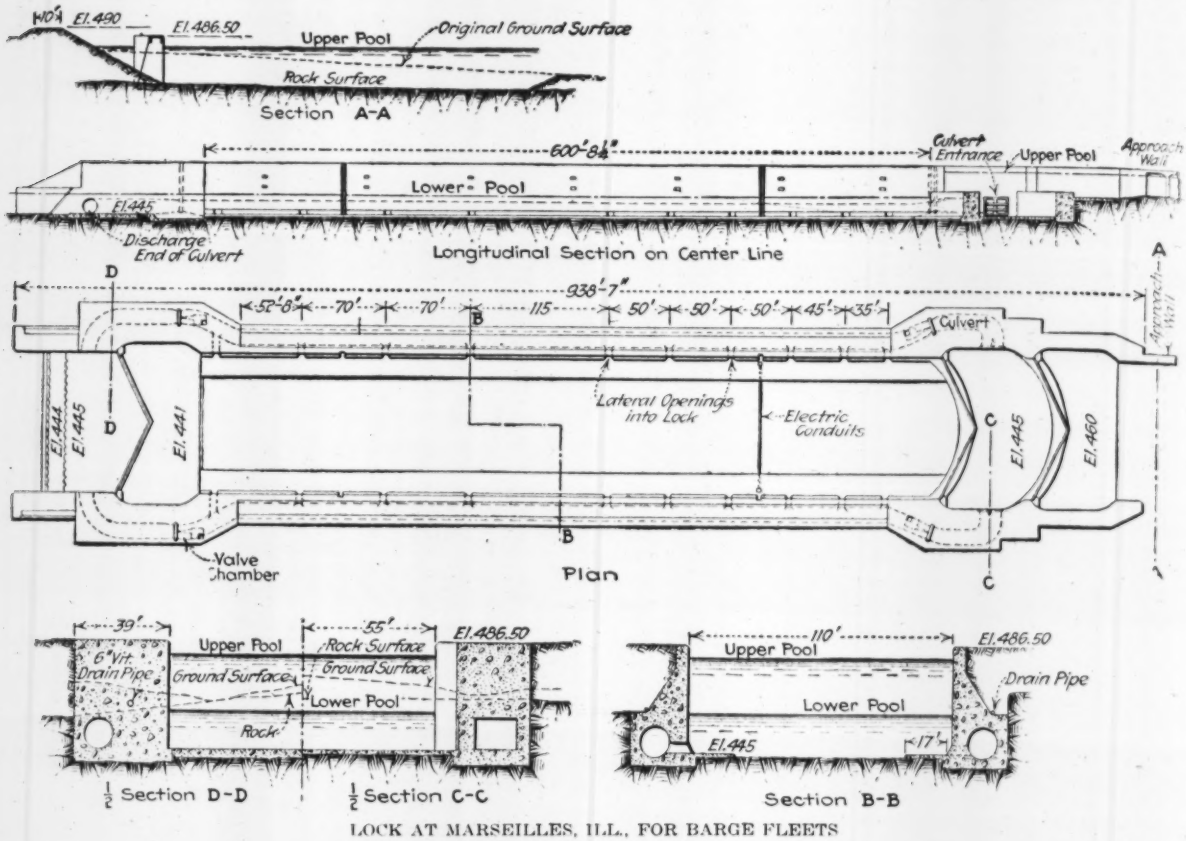
Present Project.—In 1919, the matter was taken up actively by the new Division of Waterways, which had been created in a reorganization of the State administration. Plans were made for a waterway from Lockport to LaSalle, having 8 ft. of water in earth and 10 ft. in rock sections, with a minimum bottom width of 150 ft. Locks are to be 110 x 600 ft., with 14 ft. of water on the sills at low-water stages, so as to provide for the possibility of a future 14-ft. channel. This size of lock will permit of handling barge fleets with 7,500 tons of cargo and it was adopted on account of its successful use on the Ohio River for handling barges in fleets. With this project and with the present flow of water from the Chicago drainage canal it will be possible to remove the existing dams and locks in the lower part of the Illinois River and to maintain a 9-ft. open channel from LaSalle to the Mississippi River, as well as in parts of the present project. Water power development to the extent of 60,000 hp. is included.



MAIN CULVERTS FORMED IN LOCK WALLS

In 1919 the State legislature passed an act authorizing the construction of the work thus planned. This act repealed that of 1915, which had been nullified by the opposition of the Federal government. The law provides that the State may construct power plants and lease the output, or it may lease the water to a lessee who will build the plant. In either case, the leases are to be for terms not exceeding 30 years, and in the latter case the plant will become the property of the State on the expiration of the lease.

After the passage of the act of 1919 the general plans were submitted to the Federal government and were approved by the Secretary of War and the Chief of Engineers, U. S. A. An application for permission to develop the water power has been made under the



LOCK AT MARSEILLES, ILL., FOR BARGE FLEETS

provisions of the recent Water Power Act. Proposals have been invited for the construction of some of the locks. In October, 1920, the first contract, for the lock at Marseilles, Ill., was awarded to Green & Sons Co., Chicago, at $1,373,115. This contract does not include the gates, valves or operating machinery.

Excavation for the channel and locks will amount to about 2,500,000 cu.yd., of which 1,500,000 cu.yd. will be for the Marseilles diversion channel and will be mainly in shale. The remainder will be in the river channel and will be largely glacial drift.

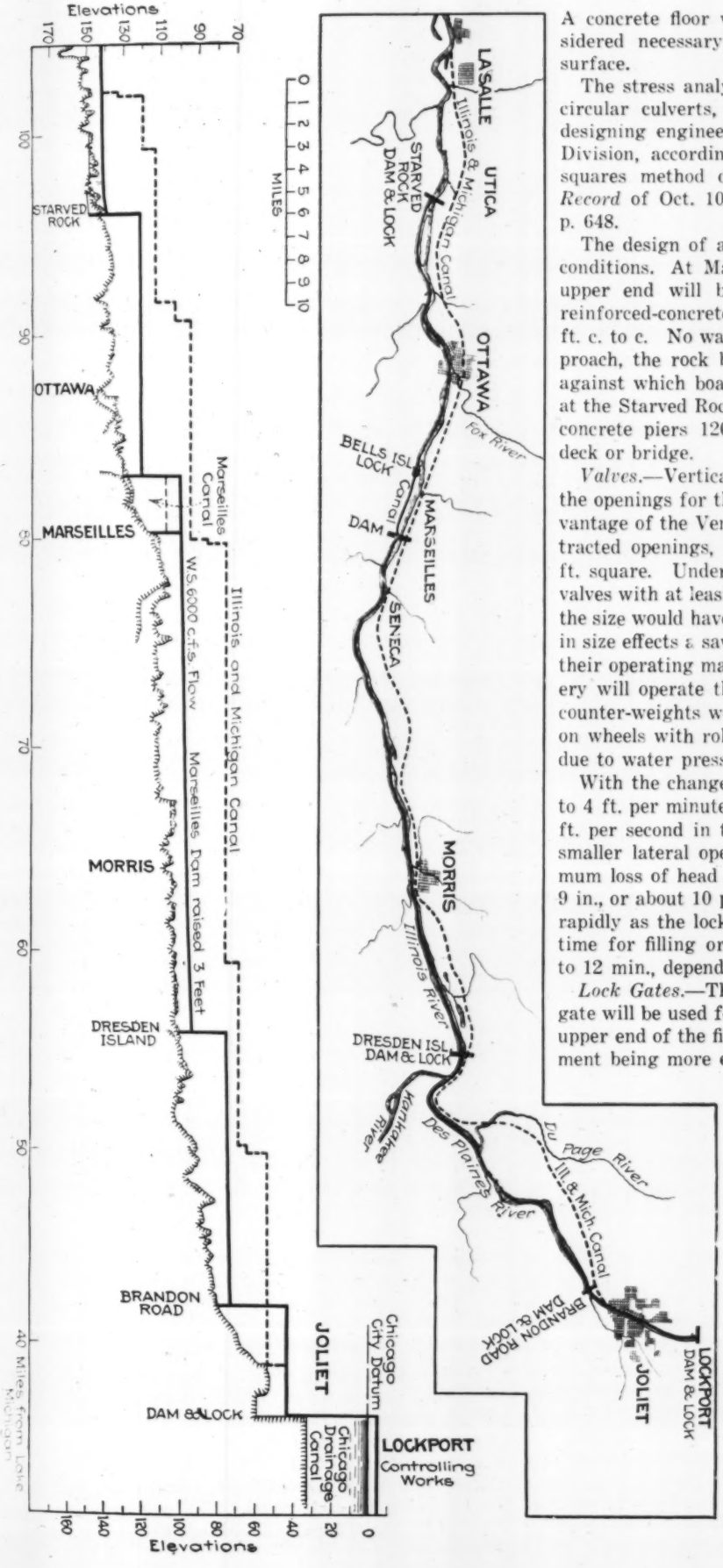
Locks, Dams and Bridges.—Five locks will be required, three with new dams and one in a diversion canal below an existing dam. All locks will be provided with power houses, except at Lockport, where the Sanitary District of Chicago has a hydro-electric plant. The new dams will be of concrete, of the gravity type, and both new and old dams will have movable crests formed by Taintor gates in order to provide ample capacity for the passage of floods.

Lock 1, at Lockport, Ill., will overcome a difference of 41 ft. between the levels of the drainage canal and the Desplaines River. Lock 2, at Brandon road, south of Joliet, will have a 30-ft. lift and here will be a lock of 18 x 110 ft. connecting with the old Illinois and Michigan canal. Lock 3, with 16-ft. lift, will be at Dresden Island, half a mile below the junction of the Desplaines and Kankakee Rivers. The dam will raise the level of both streams and extend navigation on the Kankakee about five miles above its present limit.

Lock 4, at Marseilles, with a lift of 21 ft., will be at the lower end of a canal or diversion channel, 13,000 ft. long, 200 ft. wide and 10 ft. deep. This diversion is to avoid heavy work in the river, to prevent interruption to existing water-power plants during construction of the waterway, and to develop additional head for power development. The present dam at the upper end of the new channel will be utilized, but the pool level will be raised about 5 ft. by Taintor gates on the crest. Lock 5 at Starved Rock, with 16-ft. lift, will connect the waterway with the Illinois River. As this lock is below the mouth of the Fox River, the dam has to provide spillway capacity for floods up to 80,000 sec.-ft. For this purpose there will be eleven Taintor gates 60 ft. long, ten of these being 17 ft. high and the other only 5 ft. high in order to pass ice and floating debris.

New bridges will have to be built across the present channel in Joliet, as the first lock will raise the water level nearly to the present structures. As a width of 270 ft. is specified for this part of the work, it is proposed to employ one movable span and one fixed span. Several bridges on the lower part of the channel will have to be rebuilt. Bridge plans are not completed, however, and the headroom to be provided has not been determined.

Lock Design.—Culverts formed in the side walls and having lateral openings into the lock chamber, valve chamber openings designed on the Venturi principle, together with miter sills designed as horizontal arches, are distinctive features of the locks. Drawings of the Marseilles lock, which is a typical structure, are given above and on pg. 1098. For side walls a gravity retaining-wall section has been adopted, with the 12-ft. filling and emptying culverts formed in the walls instead of beneath the floor for reasons of economy. It is estimated that this arrangement will save $25,000 per lock as compared with that of floor culverts used in the locks of the Panama and Sault Ste. Marie canals.



A concrete floor will be used only where it is considered necessary to prevent erosion of the rock surface.

The stress analysis for these walls with the large circular culverts, was made by Walter M. Smith, designing engineer of the Illinois State Waterways Division, according to a modification of the least-squares method described by him in *Engineering Record* of Oct. 10, 1914, p. 407, and May 22, 1915, p. 648.

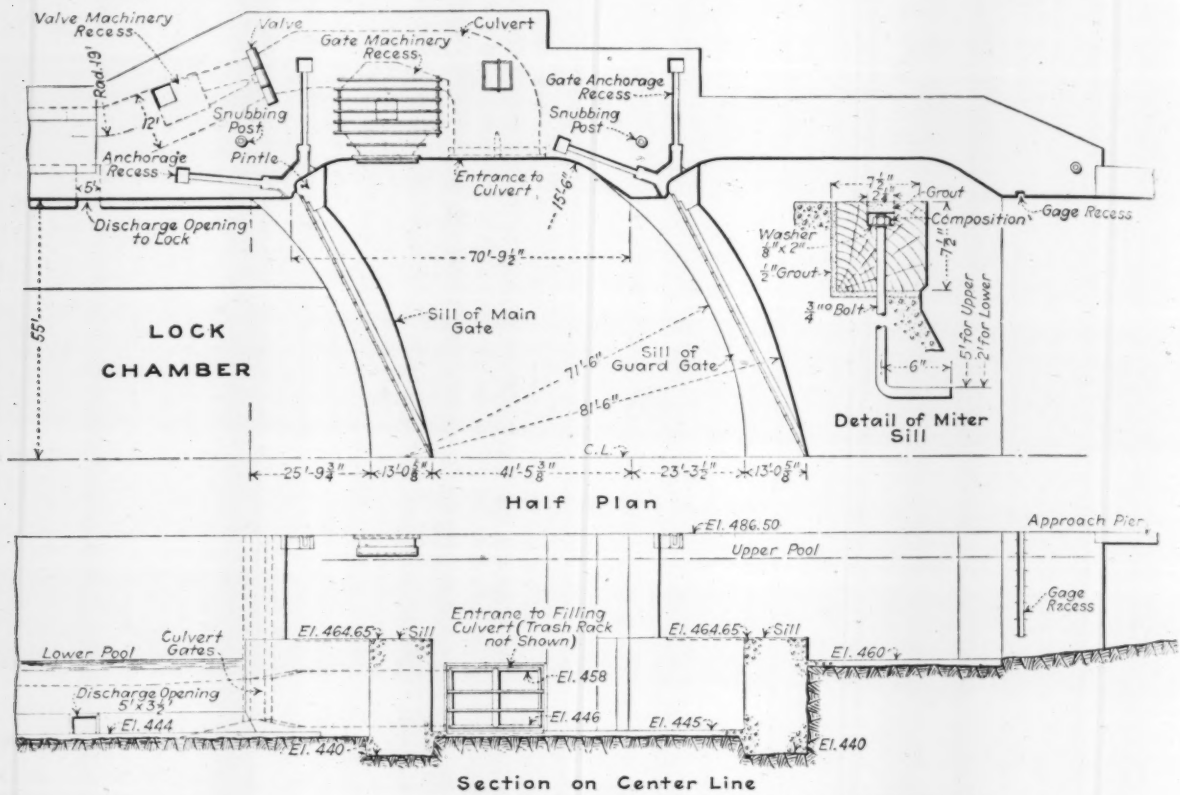
The design of approach walls will vary with local conditions. At Marseilles, the approach wall at the upper end will be of the bridge type, having a reinforced-concrete deck supported on piers spaced 20 ft. c. to c. No wall will be required at the lower approach, the rock being high enough to form a wall against which boats may be moored. Ice conditions at the Starved Rock lock will be met by placing large concrete piers 120 ft. c. to c., with no connecting deck or bridge.

Valves.—Vertical lift valves have been adopted for the openings for the filling system, but by taking advantage of the Venturi principle of flow through contracted openings, the size of valves is reduced to 9 ft. square. Under the usual method of making the valves with at least the same area as the main culvert the size would have been 12 ft. square. The reduction in size effects a saving in cost for both the valves and their operating machinery. Electric hoisting machinery will operate the valves by means of chains. No counter-weights will be used, but the valves will ride on wheels with roller bearings to reduce the friction due to water pressure.

With the change of water level in the lock limited to 4 ft. per minute, the maximum velocity will be 22 ft. per second in the main culvert and 30 ft. in the smaller lateral openings for the valves. The maximum loss of head due to the smaller opening will be 9 in., or about 10 per cent, but this loss will decrease rapidly as the lock fills. Under these conditions the time for filling or emptying a lock will be from 7 to 12 min., depending upon the lift or head.

Lock Gates.—The vertical lift or floating type of gate will be used for the main and guard gates at the upper end of the first lock, at Lockport, this arrangement being more economical than the provision of a moveable emergency dam to control the upper level in case of failure of the gates at the lower end of the lock. Each of these upper gates is designed to be raised readily against a full head of water should such an accident occur. A similar arrangement is employed for the lock in the Mississippi River dam at Keokuk, Iowa. (See *Engineering News*, Nov. 13, 1913, p. 964.)

All other lock gates will be of the mitering type, with horizontal framing. Each gate will have a single steel skin of plating on the downstream side, except that the lower gates of the first two locks will have a double skin for 15 ft. from the bottom in order to form a buoyancy chamber and



MITER SILLS AND CULVERT CONNECTIONS AT UPPER END OF MARSEILLES LOCK

thus reduce the bearing stress on the pintle and yoke pin.

A spring bearing of the gate against the miter sill so as to form the water seal is a novel construction used here for the first time and designed to simplify the design of both gate and sill. In the ordinary method, where leakage is prevented by the bearing of the gate leaves against the sill, this sill and its miter wall must be designed to withstand a possible pressure equal to 66 per cent of the total water pressure against the leaf. At the same time, the leaf has to be designed to take care of the deflection and stresses of vertical members with the leaf held at the bottom and having water pressure on its upper side. In the new design this uncertainty of stresses is eliminated, since the bearing spring can transmit to the sill only the pressure due to the water in contact with the spring. A material saving is thus effected in the cost of both the gate and the sill, the latter being designed as a horizontal arch instead of as a gravity wall.

Operating machinery for the miter gates will be of the bull-wheel type as used at the Panama canal, which arrangement permits of using a constant-speed motor to give a variable speed to the gate.

Ice conditions in the river will be improved by the new waterway, as explained by M. G. Barnes, chief engineer, in a paper read before the Western Society of Engineers. Much of the water is used at Chicago for domestic and manufacturing purposes and for sewage dilution, so that there is a flow of relatively warm water to be cooled by the air and by the water from tributary streams. This action leads to the formation of continuous fields of floating ice, which under present conditions cause great gorges, backing up the water and resulting in destructive floods. It is expected that when the waterway is in operation the discharge at the dams can be so regulated as to prevent serious ice gorges.

The traffic capacity of the waterway is estimated at 60,000,000 tons annually. In the paper noted above Mr. Barnes stated that the greatest usefulness cannot be reached until both the Illinois and the Mississippi rivers are improved to give a 9-ft. channel and until the various shipping centers provide adequate facilities for the handling and storage of freight.

This Illinois waterway project has been planned by and carried out under the direction of the waterways division of the State Department of Public Works and Buildings: F. I. Bennett, director of public works; W. L. Sackett, superintendent of waterways. M. G. Barnes is chief engineer of the Waterways Division and L. D. Cornish is assistant chief engineer. The cost of the work complete is estimated at $20,000,000, with $8,000,000 addition for water power development aggregating 60,000 hp. It is expected to have the waterway ready for operation by 1924.

A Wood Truss Flagpole

A timber-trussed flagpole 207 ft. high, built of native pine, has been erected at Corinda, Queensland, Australia. It is cigar-shaped in elevation and rectangular in section, with four curved chords united at the ends and giving a section 7 x 7 ft. at the middle of the pole. Horizontal members divide each side into panels, with diagonal bracing in each panel. The pole was built and erected by the Queensland Timbers Co.

Trend of Highway Development —a Survey

Arkansas Practice

THIS IS THE FOURTH *of a series of staff articles on the highway situation. It discusses work in Arkansas where 4,000 miles are completed or under contract and where improvement districts have been formed.*

The fifth article in the series will appear in next week's issue.—EDITOR.

ARKANSAS is the state of astounding facts in highway development. Within two years it has changed from one of the most backward to one of the most progressive states of the Union in the construction of improved roads. Beginning, practically, in 1919, the state has projected 9,000 mi. of roads of which 4,600 mi. have been completed or are under construction or contract. The remaining 4,400 mi. are in various preliminary stages of organization and it is probable, and, incidentally, desirable, that a considerable proportion of the projects may not complete their organization.

With 300 mi. completed and 4,300 mi. under construction or contract, the state ranks extraordinarily high in the value and the mileage of improved road work in progress. This, moreover, is not the complete tale. Of the 4,300 mi. under construction all but 250 mi. is of a higher type of construction than permanently graded earth road. The types of construction are, as precisely as may be determined, as follows: One-course concrete, 192 mi., asphaltic concrete on stone or concrete base 629 mi., penetration macadam, 460 mi., waterbound macadam 560 mi., gravel surfaced, 2,209 mi., and earth road, 250 mi. Of completed mileage, the majority is of the two more permanent types.

Realization of the statistics quoted as applied to Arkansas is in one sense difficult. Despite its recognized natural wealth, the state has been conceived, and to a large degree rightly conceived, as one of bottom and overflow lands, cypress brakes, undeveloped hill lands and sequestered agricultural districts. Its roads outside of limited areas adjacent to centers of population have been visualized, and correctly so, as trails impassable during the wet months to heavy vehicles. The contrast, with this picture, of 4,500 mi. of high class highways under construction and nearly as great an additional mileage planned, requires a revision of thought which is not immediately accomplished. It is hastened, however, if it is kept in mind that the very conditions indicated are due to poor roads and that the only manner in which these conditions can be reversed is by improved roads.

The total estimated cost of the 4,300 mi. of highway under construction or contract is $56,000,000. The costs per mile range from $5,000 for the cheapest graded earth road to $58,000 per mile for a 20-ft. concrete surface on a 30 ft. road bed. These costs include permanent drainage structures. On present estimates the total possible aid funds in a five year period, 1917-1921, are: State aid $1,400,000 and Federal aid, $4,615,210, a total of about $6,000,000 or slightly over 10 per cent of the estimated cost of $56,000,000, assuming that all aid funds will have been expended on the 4,600 mi. completed and under construction, which quite certainly will not be the case. Over 90 per cent, therefore, of the cost of the construction completed and in progress is being financed by special assessment on the real property adjoining and benefitted by the improvements. Naturally the same fact will be true of that portion of the projected 4,400 mi. which may be actually constructed. Except, possibly, in Texas, where similar conditions exist, this practice has its parallel in magnitude nowhere in the United States.

Under its constitution, Arkansas cannot undertake works of public improvement. Neither the State nor the county can issue bonds. Highway construction is performed by the organization of improvement districts created under a general road law and by special acts. Under the general law the cost of the road is limited to 30 per cent of the assessed valuation of the land in the district. Where this sum is insufficient to build the road, the district seeks a special act of the Legislature empowering it to raise money exceeding the general law limitation as it may desire. In 1919 and 1920 there were created about 300 road districts by special acts. To illustrate the condition described in a more specific manner, 70 districts of which complete data are available, show the average cost per mile of road to be $14,500 and the averaged assessed valuation per mile of road to be $36,600. Under the general law limitation of 30 per cent, the permissible expenditure per mile is $10,980 which is not enough to build the roads. Therefore, the districts must secure power by special acts to increase expenditure.

Highway improvement districts, as usually formed, embrace an area extending about three miles on each side of the road to be improved. These districts have boards of commissioners which appoint the engineer and other employees and have charge of the work. If the district is granted aid, the plans, specifications and estimates have to be approved by the state highway department which also inspects and passes the improvements before aid is paid. Here is to be noted the complete independence, except where State or Federal aid is sought, of the district from any outside control. It can, as it sees fit, under the special act which governs it, finance the improvement, chose its route, select the type of construction, appoint its engineer and contractor and manage the construction. Generally, the districts seek aid from and work harmoniously with the state highway department but their independence is complete and at times has been asserted by waiving aid and conducting the improvements as desired.

RESULTS OF THE PAST

A number of circumstances have developed from the conditions: (1) Engineering direction has not been in all instances the most competent; (2) non-technical commissioners have on occasions over-ruled their engineers and adopted fancied types of construction not the most suitable; (3) districts have frequently overreached themselves in expenditure undertaken; (4) districts have competed with each other for materials and labor with consequent inflation of costs; (5) anxiety to realize the improvement has caused unwise financing and particularly the marketing of bonds at high discounts; (6) roads have been located frequently without proper consideration of a coordinated system of main routes and not always without local favoritism.

Other criticisms are possible and while all are true they are far from being generally true. Indeed there is evident a surprising unity of purpose and quality in

the main highway system being produced by largely uncorellated interests. The local initiative and responsibility create an interest which hasten and disseminate education in highway development. Road improvement is more than commonly an expression of popular consciousness of a necessity. Stabilizing influences are: (1) the authority wielded by the State Highway Department in allotting state and federal aid and (2) the sound professional standards maintained by the leading engineers engaged in highway practice.

Structurally the types of road being built call for particular mention only in respect to the asphaltic concrete and gravel surfaced types. The asphaltic concrete construction is a 2-in. surface, usually Topeka mix, sheet asphalt or Warrenite on either a "broken stone" base or a concrete base. The term "broken-stone" base is really a misnomer; this base is a 5-in. waterbound macadam of the best construction frequently built between 6 x 10-in. concrete curbs. Choice between broken stone and concrete base is ordinarily determined by cost (roughly broken stone is $5,000 a mile cheaper) but structural considerations also enter. On fills and soft subgrade the concrete base gives needed strength and generally an asphalt on concrete is without a certain waviness almost impossible to eradicate with a macadam base. Preference for asphaltic concrete compared with cement concrete, as indicated by the respective mileages under construction, however, is almost wholly decided by relative costs.

In total mileage, gravel roads surpass all other types. They are particularly well constructed. A base of clay gravel 5 in. thick when consolidated is rolled to profile and on this a surfacing of finer gravel is consolidated to 2½ in. by rolling. Gravels suitable for road surfacing are generally plentiful except in the alluvial bottom lands in the eastern part of the state. Here long hauls are necessary. In other parts of the state chirt and novaculite rock are also plentiful. The state does not lack bulk materials for highway construction. In 1920, however, due to transportation shortage, highway contractors have not been able to secure on the job much more than 10 per cent of the material required for normal progress.

Construction Problems

Construction problems in Arkansas are peculiar in the respects (1) that wet weather, which is plentiful, because of the soil conditions practically shuts down operations, (2) that much of the location is through virgin territory and land clearing and grubbing are expensive operations, and (3) that work in the bottom lands subject to overflow necessitates raising the road on embankment with large drainage ditches. These conditions call for types of construction equipment such as dredges and clearing and grubbing tools, which are not ordinarily prominent in highway construction plant, and they also put out of commission many of the heavy hauling and grading units commonly employed. For many conditions nothing yet developed surpasses in effectiveness "the nigger and the mule" as a road-grading tool.

Because of the improvement district plan which disregards county boundary lines large mileage highway projects and also large mileage contracts exist in unusual numbers. Projects exceeding 50 miles are frequent. In the southern and eastern part of the state the Arkansas-Louisiana highway is 153 miles long in five counties. The improvement district embraces 67 000 acres and the work will cost upward of $3,500,0 Of the total mileage 111 mi. are asphalt on concr base. An article analyzing and describing the co struction methods employed on this project will be published in a future issue.

Commonly highway activity is measured by counties, for despite the improvement district plan the county remains the political unit and normally the improvement district manifests a tendency to keep within county lines. Some Arkansas counties have undertaken upward of 200 mi. of improved road. A noteworthy but not exceptional example is Phillips County in which the city of Helena is located. Because this county exemplifies the typical methods of the more progressive county, the development of its highway program is summarized as follows:

District	Date	Miles	Cost	Type
1	1915	2	$54,000	18 ft. concrete
2	1916	6	192,000	18 ft. Topeka top on 5-in. concrete
3	1919	14	443,000	14 ft. Warrenite top on 5-in. concrete
4	1919	34	992,000	14 ft. Warrenite on 6-in. stone
5	1919	73	1,700,000	14 ft. Concrete
6	1919	6½	190,000	18 ft. Topeka on 5-in. concrete
		135½	$3,641,000	

The costs given are contract prices. To them there is to be added about 10 per cent, made up of 2 per cent for legal fees, 5 per cent for engineering and about 3 per cent for general administration. Including street improvement districts in Helena the charge *per capita* for the highway improvements undertaken in Phillips County will exceed seventy-five dollars. This is typical of the financial obligations for highway work which many Arkansas counties have been ready to undertake. The great difference in sizes of districts—two miles to 73 miles—is typical, as are different engineering direction for each district, different contractors and different types of paving.

One comes from a survey of Arkansas highway practice with decidedly mixed impressions. Admiration is commanded by the energy of purely local initiative by which the highways of the state are being lifted out of their primitive sloughs of mud. Apprehension of trouble in prospect is created by the same popular tendency to assume burdensome financial obligations. Veritable alarm seizes one at the frequent willingness exhibited to drive ahead with improvements on money raised by selling bonds at enormous discounts. And finally the part which politics plays in all matters of highway development arouses unqualified condemnation. In noting these obvious shadows the disposition to regard the whole view as dark should be guarded against. This is not the true vision. There is much to admire in the manner in which highway improvement in Arkansas is being achieved. In particular one is encouraged by signs of reform.

Moderation is being shown in placing projects under contract. The State Highway Department is discouraging extravagant financing. There is a strong sentiment developing that the Legislature should review all projects on which no work has been done and repeal many of the special acts under which these projects exist. Growing out of this sentiment is a spirit of greater caution in projecting improvements. The day of wild-cat highway improvement projects has probably passed for Arkansas.

Water-Borne Outbreak of Typhoid at Schenectady, N. Y.

POLLUTION of a water-works well at Schenectady, N. Y., due to high water in the Mohawk River, caused 53 cases and 3 deaths from typoid in that city. The following summary of the outbreak, by Theodore Horton, chief engineer New York State Department of Health, is taken from *Health News* (the monthly bulletin of the department) for October, 1920:

The water supply of Schenectady is derived from three large wells on the south side of the Mohawk River, electrically-driven pumps sending the water into the mains of the city. Some years ago, however, steam pumps located in the same building that now houses the electric equipment were used to pump the water from the one well then in existence. These steam pumps, in addition to being connected to the well, had two 24-in. cast-iron suction pipes extending into the Mohawk River for use in case of emergency. Both of these suction lines passed through the well above the normal water line. Some time after the abandonment of the steam plant and the construction of the additional wells these pipes were disconnected, the part passing through the well removed, and the walls of the well sealed up with masonry. The suction pipes had been laid in brick tunnels with gravel bottoms for a short distance each side of the well, and the portions in these tunnels were also removed. From the end of the tunnel on the north side of the well to the river, however, the pipes were left in place, the ends projecting into the tunnel. One of these ends was carefully sealed with concrete, but through some oversight the other was left open. Under normal conditions this caused no trouble, for the open pipe was above ordinary high water.

On March 13, 1920, due to thaws and ice jams, the water in the river rose to about 7 ft. above the bottom of the open pipe to the river, and then slowly fell again until it was below the bottom of the pipe on March 20. Thus for seven days there was nothing to prevent the polluted water of the river from flowing through the pipe into the tunnel and thence down through the few feet of gravel into the well. The fresh deposits of river silt in the tunnel and the wash holes in the gravel bottom of the tunnel at the time of the inspection indicated plainly what had occurred. An extraordinary turbidity of the water was noticed.

On March 15, the second day after the extreme high water, and during the few following days, a large number of cases of gastroenteric disturbances were reported. During the latter part of March and the first part of April 53 cases of typhoid were reported, the greatest number of the onsets occurring between April 1 and 6, or from eighteen days to three weeks after the extreme high water in the river.

When the cause of the turbidity in the water and the unsatisfactory bacteriological quality was brought to the attention of the city authorities by the Engineering Division of the State Department of Health the city authorities immediately sealed the open end of the pipe and later removed a portion of both of the old suction lines between the well and the river, thus precluding any possibility of future pollution of the water supply from the same cause.

The issue of *Health News* from which the foregoing paragraphs were taken contains reviews by Mr. Horton of a number of other typhoid outbreaks in New York State. The Schenectady outbreak is described in much more detail by Mr. Horton in *Public Health Reports* (Washington, D. C.) for October 29, 1920.

Geologic Classification

Under the new mineral-leasing law it is incumbent upon the U. S. Geological Survey to determine the geologic structure of producing oil or gas fields and to divide the coal, phosphate, and oil-shale lands of the public domain into appropriate leasing units.

LETTERS TO THE EDITOR

What Will the American Society of Civil Engineers Do With Its "Proceedings"?

Sir—I have just read your editorial "What Will the American Society of Civil Engineers Do With Its *Proceedings?*" in the Oct. 21 issue of *Engineering News-Record*. Whatever changes are made in *Proceedings* or *Transactions*, whether or not *Proceedings* is expanded to magazine form, I hope that all members—speaking from a purely selfish point of view and arbitrarily assuming that others also desire what I consider an essential ingredient of *Proceedings*—will receive at intervals announcements of titles and publishers of new books and current engineering literature. While this has to do with "dissemination" it is of equal if not greater importance to the advancement of engineering or any other kind of knowledge or practice.

It is unnecessary to dwell upon the advantages of a technical library to a professional man. At the present rate of progress in engineering and other technical and scientific fields who can hope to keep abreast of the advancement even in his own particular field without the possession of or easy access to an up-to-date library? If, then, this is necessary to keep pace with the advancement of knowledge is it not more essential to one who hopes, by however small a contribution, to add something to the advancement of the knowledge or practice of his art?

The "Engineering Literature" and "Publications Received" sections of *Engineering News-Record* are an excellent example of an easy access to an engineering library. Those who favor "the cutting of the garment to the cloth" idea in your editorial will say immediately that this answers the question; subscribe to *Engineering News-Record* and cut down the *Proceedings*. My argument for continuing such sections as these in the *Proceedings* is that such material does aid in advancing engineering knowledge and practice and is therefore in accordance with the aims and purposes of the society. Furthermore, I believe this will be of more permanent benefit to members most of whom I believe will have bound copies of *Transactions* on their book-shelf long after they have thrown away or sold bound volumes of *Engineering News-Record*, if indeed they ever preserved such volumes at all.

WILLIAM A. CALLAWAY,
First Lieutenant, Corps of Engineers, U. S. A.
Camp Grant, Illinois, Nov. 17.

Concrete Columns in the Galveston Fire

Sir—The description of the results of the two fires in the warehouse at Galveston, Tex., in your issue of Nov. 18, p. 980, gives food for much thought on the subject of reinforced-concrete design. To my mind the greatest lesson is the old lesson of practically every reinforced-concrete failure or fire, including the Edison fire and one in a tobacco warehouse at Norfolk, Va., recently told about by the fire underwriters. This is the utter unreliability of rodded columns in any structural emergency.

The Edison fire showed the weakness of square rodded columns by excessive spalling, even in rooms where the heat was not sufficient to melt the insulation off electric wires; and it also exhibited the futility of so-called reinforcing (upright) rods in the middle of the side of these square columns, for in many cases these rods spit the columns and burst out the sides.

In the Norfolk example the rodded columns acted in the usual way; the rods curled up in fantastic fashion, showing how they reinforce (?) a column. The columns failed, with practically total destruction of the building.

In the Galveston building the columns, while round, were of the usual rodded-column standard and were not reinforced with close-spaced hoops as real hooped columns must be. Their action in the fire was on a par with that of square rodded columns in other fires and wrecks.

W. J. Knight emphasizes the destruction of concrete where there were sharp corners, and cites the drops at column

heads which broke off. There is no doubt much in this, but there is another thing about the drop of the slabs contributing to this destruction, the absence of reinforcement in these drops. If they had had a mesh of steel tying the drop into the slab there is no doubt that they would have stood up immensely better under the fire.

The column capitals, Mr. Knight says, were greatly impaired by the damaging effects of the heat. This, too, can be explained by the absence of reinforcement in these capitals, for the shape is certainly not such as to invite destruction by reason of sharp corners.

It is to be noted in your photograph on page 980 that just where the column capitals were, and presumably where the columns were strongest, many of the columns are entirely gone. In a design which I reviewed some years ago I recommended that the column capitals be reinforced. It is certain that if these had been reinforced the capitals at least of the columns, which in a flat-slab building carry a large portion of the slab weight, would have held together very much longer and with proper columns would doubtless have needed only replastering instead of reconstruction. The weakness and failure of the columns is amply confirmed by the photographs. It is inconceivable that anything approaching this destruction could have occurred if the columns had been reinforced with close-spaced hooping.

Mr. Knight says that the columns in most cases were the initial cause of failure and Mr. Besselievre says that, even under intense heat, in the other fire the floor slab stood up very well.

I do not share Mr. Knight's apprehension regarding construction joints. In my judgment the destruction at construction joints was due to cumulative effect. The great expansive force of the floor slab had to have an outlet somewhere, and as the construction joints were the weakest portions of the slab the force was concentrated at these joints. If such a thing had been possible and the floor slab had been poured in one operation it is probable that the expansive force would have caused buckling of the slab in very irregular lines, and the difficulty of straightening up the floor level would have been greater.

In this case, as in practically all failures of construction, design is at fault; and the thing to blame is the standards of design that allow and recommend such things as rodded columns.

EDWARD GODFREY.

Pittsburgh, Pa., Nov. 22.

Sir—Your articles on the effect of fire on the reinforced concrete warehouse at Galveston [*Engineering News-Record*, Nov. 18, p. 980] are exceedingly interesting. The fire resisting properties of reinforced concrete are of such vast importance to engineers that too much information on the subject cannot be collected. The difference in the effect of the two fires, causing complete destruction in the one instance and not in the other, seems peculiar, but the writer believes this can be readily explained in view of the facts stated.

To get down to fundamentals, the real cause of failure of reinforced concrete during fire is the steel, and it will be helpful to consider the behavior of this metal under rising temperatures. Tests made in Great Britain during the war indicated that the yield point and tensile strength of steel fall very rapidly as the temperature rises. There is a marked falling off at even 250 deg. C., while at 500 deg. C. the reduction in tensile strength is very great. In the case of the earlier fire, on May 29, this occurred on the second floor. The second story was packed nearly full with sisal, which would readily absorb water and become exceedingly heavy. It seems highly probable that the full design load of 375 lb. per sq.ft. came on the floor after the sisal had become thoroughly saturated.

With a fire of such intensity it seems reasonable to presume that the steel became heated well above 500 deg. C. Its tensile strength could easily have been reduced to one-quarter of its normal strength. With the full design load on the slab it can be readily seen that failure would result. In the later fire the seat of the conflagration was on the first floor. The upper story in this instance had but one-quarter of the maximum load, and as far as can be gathered by the articles this load would not be increased by water during the fire. Although the tensile strength of the steel must have been considerably reduced it was still able to support the comparatively small load above. While the floor may still appear sound it seems difficult to imagine that the steel in the concrete has not been seriously impaired.

It would seem that to obtain better fire resisting properties of reinforced concrete lower working stresses together with a thicker protective coating on the steel would be advantageous, although it would add considerably to the cost and might not be deemed worth while.

High Point, N. C., Nov. 23. EDGAR A. CROSS.

Is Surveying a Trade?

Sir—I am interested in what A. L. Dabney says on "Is Surveying a Trade," in your issue of Nov. 11, p. 956. My practice is mainly land surveying, but I am now and then called in to do work which might be classed as minor engineering. In my experience, dating back to 1880, I have many times caught technical men in serious errors in land surveying. On the other hand, I have found excellent work done by men who had picked up surveying without education. A level head and a technical training make a strong combination. But who is the tradesman: the non-technical man who does careful and accurate work, or the technical man who blunders? My experience is that educated engineers, who should be the best, are careless land surveyors.

Hackettstown, N. J., Nov. 15. E. N. MILLEN.

The Writing of Engineering Reports

Sir—The valuable hints on the writing of engineering reports in your issue of Nov. 4, p. 891, by Prof. Mead, than whom there is no one better qualified to give advice, should be read with profit by every engineer. The subject would justify a volume, which few are qualified to write. This subject is touched but little, if at all, at the colleges and possibly cannot be treated adequately in a college curriculum, but instruction must be acquired in some way to enable an engineer to suitably present the subject matter and findings of a report which he may be called upon to make.

We have occasion to handle a great many reports of other engineers and have been so much surprised and disappointed in their character and form that we have come to expect that they will be inadequate and unsatisfactory, in which preconceived notion we are seldom mistaken. Much is said about the lack of proper instruction in writing good English in the technical colleges, but this does not wholly explain the fact as an author known to be well educated may prove unable to treat this subject in a comprehensive and lucid manner. The following notes may be considered relative to what a good report should be and should not be.

1. A good report must be brief and concise yet not too condensed. This implies a matter of careful judgment. Brevity is desirable, but when treatment is too much condensed it fails of its effectiveness. A more expanded treatment is effective, if logical and clear.

2. A good report must deduce the findings and not express merely guesses on the part of the author. Much can be accomplished by deducing results step by step from unquestionable facts, findings and data, expanding the subject as the discussion proceeds, making the steps plain and the manner of deduction evident.

3. A good report will employ approximations and averages with the utmost discretion. A vicious thing in many reports is the way approximations and general averages are used. Approximate figures must be employed at certain points and averages have their uses, but the approximating should be done on the unit figures where there is an opportunity to employ judgment, and not on "per mile," "per annum" and other such figures. The writer has a particular aversion to averages as employed by the average engineer. How many times we see in engineers' reports a statement like this: "The average revenue per mile of other

electric lines in Texas is ——— dollars. Taking this average, we have ——— dollars for the income per year for the proposed electric railway." No notice is taken of the fact that this proposed line may be unlike the existing roads, or of the further fact that there is no more reason to expect that it should be just in accord with the average than that it should be in keeping with the maximum or minimum.

4. A good report will treat not only the technical problems involved but the business aspect of the matter. Frequently reports are found to contain exhaustive discussions of problems of engineering design and bring forward fairly satisfactory estimates of cost of construction and there stop, without any reference whatever to cost of operation or income. Occasionally reports may be called for upon purely technical questions, but the great majority have for their objective the solution of financial or financing problems. That being the case, it is the duty of the engineer to treat income and expense with equal thoroughness. A good report, when dealing with capital requirements, will treat thoroughly of the following:

A. The need for the money, in general terms.

B. What is to be done with the money. This implies descriptive specifications of what is proposed to carry out the project as outlined. There should follow estimates based upon the specifications which must be submitted to constitute a basis for such estimates.

C. Determination of operating expense in detail as thoroughly as if the property was to be put in operation immediately.

D. Determination of net earnings. In other words, a scientific deduction must be made of the amount of money which the investment that is to be solicited will earn.

E. A good report will be as free as possible from personal opinions of the writer. His opinions will be expressed in the determination of unit figures and fundamental estimates, but beyond that they had best be left to a final chapter in which the author may express himself freely and convey any suggestion that may be beneficial to the client.

If the engineer is to command respect and consideration he must be able not merely to write good English but to formulate and compile and logically set forth information, statistics, data and findings in a manner which will be not only clear but convincing and impressive. In passing, a quotation from an engineer's report on a proposed new railway may be given as an example of how not to write a report: "The grades and curves will be easy and the line will probably be operated by electricity and there won't be any rock so the line will not be expensive to build, and there will be plenty of travel because the country is well settled with a good class of people that raise cattle and hogs, and the dairy business is a great business in that region so there will be a lot of milk cans and butter and eggs that can be carried every day on the new road which will make the freight business good." This engineer had muddled in his own mind a number of subjects, each one of which should have separate and distinct treatment.

W. K. PALMER,
Consulting Engineer, National Engineering Service Corporation.

Kansas City, Mo., Nov. 11.

Sir—I have read with interest Mr. Mead's article on engineering reports. (See *Engineering News-Record*, Nov. 4, 1920, p. 891.) He has left little to be added.

The importance of the length of the report may be emphasized, for while it should be complete in information it should, at the same time, be concise. Confining the discussion to the points at issue and avoiding repetition will accomplish much. In fact, reiteration of subject matter seems to be a besetting fault of the novice at report writing. It arises from and also conveys a hazy conception of the subject. The preparation of an outline will assist in presenting the proper thing in the proper place.

Action on a project is sometimes delayed for many months following the completion of the investigation. It is important then that there be available a full statement of the conditions at the time when the report was made so that the conclusions may be reviewed.

Finally it has been said innumerable times, but will bear repetition, that the first essential in report writing is that the author shall know what he is writing about, and know it thoroughly and definitely. Much of the struggle for expression, both in composition and use of words, arises from a lack of comprehension of the thing to be expressed. The most remarkable thing about this obvious requirement is the frequency with which it is disregarded. During the writer's experience great difficulty has been found in securing capable assistants who can make thorough investigations and write intelligent reports.

MORRIS KNOWLES,
Consulting Engineer.

Pittsburgh, Pa., Nov. 20.

Export and Import Statistics and the Industrial Trend

Sir—The statistics of our export and import trade since Jan. 1, 1919, given by O. M. Fox in *Engineering News-Record* of Oct. 28, p. 835, should have the greatest interest not only for those of your readers who are directly interested in foreign trade, but also for the much greater number who are chiefly concerned with domestic business. The graph (Fig. 1) presented the more important of these figures in such a way that they could be understood at a glance were it not for the fact that the author then proceeded to deduce from them a number of apparently incorrect conclusions.

These conclusions appear to be based on a fundamentally incorrect conception of foreign trade and especially of the relations existing between exports and imports. The exchange of merchandise with foreign nations, as is the case with domestic business, can only be continued as long as both parties to the transaction are benefited. Under normal conditions almost the entire amount of exports must be paid for by imports of corresponding value, and by the so-called "invisible balance of trade," so that the actual balance to be settled by the shipment of gold will usually be so small as to constitute an almost negligible percentage of the total. Therefore it may be taken as inevitable that over a period of several years the exports and imports of any country will approximately balance each other.

For years prior to 1914 the United States annually reported a considerable excess of exports over imports, which was settled by an invisible balance of trade consisting principally of dividends and interest on European investments in our country, repayments on account of the principal of such investments, and the expenditures of American tourists abroad. To these must be added a gradually increasing volume of our own investments in foreign countries, which, during and since the war, have been of exceptional magnitude, whereas our payments on account of the interest and principal of the greatly reduced foreign investments in America have materially declined. In all probability our former adverse invisible balance of trade has been materially reduced and may soon be wiped out, or even replaced by a favorable balance, in which case our only important means for obtaining payment for our exports and for the interest and principal of our investments abroad will be through imports of merchandise.

It would, therefore, appear that the conclusions stated in the article are in error in the following particulars:

1. An excess of imports to settle a favorable invisible balance of trade will imply profits coming into this country, as contrasted with our former condition, in which excess of exports signified profits going out of the country to foreign investors in American enterprises. An excess of imports will hereafter be a sign of prosperity rather than otherwise, while an excess of exports may become a sign of bad business conditions, unless, unlike most other countries, we are able to invest safely abroad *all* the profits of our export trade.

2. When a nation is selling more than it is buying, exporting more than it is importing, it is not usually enjoying financial prosperity, nor experiencing relatively high prices in its home markets. On the contrary, when selling exceeds buying it is almost invariably a sign that prices in its home market are relatively low as compared with those of

the rest of the world, and that its fundamental prosperity is open to question. An exception occurs, as before mentioned, in the case of a country like the United States of pre-war days, when a high protective tariff preserved the home market for manufacturers for the domestic factories and the exports consisted largely of essential raw materials and food-stuffs. That this is really an unusual condition can readily be seen by comparison with the condition of the late European belligerents, which for a number of years to come will be obliged to put forth their utmost efforts to obtain an excess of exports over imports in order to pay off their foreign war indebtedness.

3. The present tendency of our exports and imports to balance each other by an increase of the latter rather than by a decrease of the former is, therefore, a most gratifying condition, implying a future improvement in the present prohibitive rates of foreign exchange which will enable our overseas customers to take more of our exports.

4. The author asserts that the coming change from an excess of exports to an excess of imports will imply a corresponding change from profit-taking selling to profit-paying buying, whereas it would really mean that from being engaged in selling on time, as at present, to foreign customers of more or less doubtful credit, we would become a nation of profit-taking importers. It would seem almost self-evident that under normal peace conditions no nation will have a considerable excess of imports unless it be in prosperous circumstances.

5. The conclusions of the author with reference to duty-free imports seem likewise to be based on erroneous premises. He admits that our importations of raw materials have increased 68½ per cent during the period, which would seem to indicate that our factories must be adequately supplied with all their requirements. As a matter of fact, owing to the recent severe declines in our domestic demands for such articles as raw wool, raw silk, India rubber, hides, etc., importers of these are now having the greatest difficulty in disposing of them to advantage in our markets. The increase in the imports of manufacture both actually and relatively as compared to raw materials is by no means alarming, but, on the contrary, is an indication of the return of normal conditions. It must be readily apparent that, as our principal foreign markets are the manufacturing nations of Europe, on the whole, less plentifully supplied with raw materials than ourselves, it follows that our imports from them must be manufactured articles.

6. It is even harder to agree that the present stagnation of domestic business is due primarily to the yet relatively insignificant imports of manufactures. On the contrary, the sharp shrinkage of values is a condition which is at present world-wide, and it seems safe to say that few, if any, countries have been less adversely affected by it than our own. It is to be attributed chiefly to the approaching end of war inflation, aggravated in our case by the fact that our export business has been sharply reduced by a tremendous decline in foreign exchange, which only a great increase in imports can restore to parity.

7. One of the most important questions to be decided by the next administration is that of the tariff. It must be admitted that in the past the principle of high protection has been of great value in preserving the domestic markets for our own factories, but there seems reason to doubt its value under our present conditions. As long as the total output of our factories was less than the requirements of the domestic markets and, therefore, while our interest in export trade was not vital, the high tariff was undoubtedly beneficial to the manufacturers of the country as a whole. However, if our total manufacturing capacity in the lines in which we excel is now greater than our domestic demand, leaving a considerable balance which should be exported, it follows that the tariff should be adjusted on a more moderate basis which will permit imports of manufactures which can be obtained to better advantage abroad sufficient in value to pay for increasing exports of our excess production.

ALBERT I. STILES,
Chief Engineer, Lindeteves, Inc.,
Engineers and Exporters.

New York,
Nov. 6.

[Copy of Mr. Stiles' letter in the preceding column was submitted to Mr. Fox, whose reply follows.—EDITOR.]

Sir—I regret that any one should have read into my article a brief for high tariff, as such was not intended. It was purposed purely to call industrial America's attention to the fact that a rapid and steady growth of imports had culminated in August in an amount which lessened our home markets for our home manufacturers by two and one-half billions a year. I agree with Mr. Stiles that under the circumstances this condition is inevitable and probably desirable, yet I see the situation fraught with danger for our manufacturers if they do not appreciate the extent of the shrinkage of their market and lay their plans in accord.

Who would care to be a stockholder in a concern whose managers measured their progress by their purchases rather than their sales? Such an enterprise would probably pay the same kind of dividends that the United States paid in 1893 when our imports were the largest in our history up to that time but our favorable trade balance, by a reduction in exports from $1,030,000,000 in 1892 to $847,000,000 in 1893 was reduced from $202,000,000 to $19,000,000; or the sort that were paid in 1873 when our favorable balance of $119,000,000 became an unfavorable balance of $19,000,000.

The fact is that American agriculture and industry, keyed up to a high pitch during the war and post-war periods, are capable of producing more than American needs of their output. We thought Europe would need this excess for years to come, owing to the destruction of her producing power. We now find this is wrong, and find Europe, the famished, meeting us on our own ground with goods in competition with ours. It is necessary that we face the situation and conduct our business accordingly.

Chicago, Nov. 22. O. M. FOX.

What Is Art?

Sir—Having read with great interest your editorial comment "What Is Art?" in the Sept. 16 issue, p. 531, the subsequent letters appearing in relation thereto, and Mr. Binckley's article entitled "Art in Structures" (Nov. 25 issue, p. 1024), I would like to take issue with Mr. Binckley in regard to some of the points touched upon by him, although I most heartily agree with some of the opinions he expresses.

Having had some opportunity of studying, in Europe and elsewhere, the relation of art to structures the writer feels that the degree of beauty from an architectural point of view is to some extent a matter of personal opinion founded upon good taste and the general fitness of things. Mr. Binckley speaks of the "wretched so-called architecture with which the modern world and especially the United States is encumbered"; as an answer to this, compare the modern architecture of Germany, Switzerland, Italy and France with that of the United States, and I venture to say that structures like St. Thomas' church on Fifth Avenue (New York), the Woolworth Building and the Lincoln Memorial in Washington, are, for pure architectural beauty and fitness, at least on a par with contemporary European architecture, and a great deal better than many oft-cited examples of ancient and early renaissance European architecture. As a whole, I think that the general run of European examples of later renaissance would be hard to equal or to beat for sheer vulgarity and ugliness; in this connection contemplate for a moment the Opera House in Berlin or even the Opera House in Paris.

Mr. Binckley goes on to say: "Our greatest modern engineering structures are bare mathematical skeletons of an idea . . . To a bridge engineer a great steel bridge is probably beautiful, but to an ordinary man of culture and taste it is merely large and very ugly." The writer happens to be a bridge engineer, and is somewhat curious to learn whether Mr. Binckley thinks the Manhattan Bridge and the Hell Gate Arch are intrinsically "bare mathematical skeletons of an idea." To the writer they are of high architectural merit, whereas he admits the Blackwell's Island Bridge and Williamsburg Bridge properly fall within Mr. Binckley's characterization. Why cannot Mr. Binckley's eulogy

of the Brooklyn Bridge (with which the writer agrees) apply equally to the Manhattan Bridge? As for the steel towers of the Manhattan Bridge as compared to the stone towers of the Brooklyn Bridge—is this matter really not one of relativity? We all know—even the layest kind of a layman—that steel can resist greater unit compression stress than stone, hence the greater need and fitness in the use of more massive towers if they are of stone, and even more massive towers if they consist of material less strong in compression than stone.

Some architects and even some engineers seem to think the element of decoration or ornamentation is absolutely essential in a structure before it can claim architectural distinction. How about the Campanile in Venice—a structure almost devoid of applied ornament, but to the writer's mind one of the most beautiful gems of architecture seen by him during his voyages to many parts of the world? True, the Campanile relies somewhat upon color for ornament, but the decoration is of such simple character, being one almost entirely of proportion of mass, that it is hard to reconcile the surpassing beauty of this structure with a condition which "will probably result in a cold and forbidding style."

As Mr. Binckley so well says, "of attempts at ornamentation, let him beware." In this connection consider what an unhealthy and neurotic mental condition must have been responsible for the nightmare of ornamentation seen in some of the later renaissance examples of architecture. To my mind, it is a matter of surprise that engineering structures are so often really sound from an architectural point of view.

There is no doubt in the writer's mind that the ability of Michael Angelo as an engineer (for he was undoubtedly one of the greatest of his time) was to some considerable extent responsible for his greatness as an architect. A study of St. Peter's at Rome and the Trinity arch bridge at Florence will reveal this. On the other hand it is the writer's opinion that the calling in of architects on the design of certain bridges in Paris over the Seine was a disaster, for an engineer could hardly have produced such architectural monstrosities. I most emphatically agree that architects should watch their step and beware of ornamentation, but I cannot for the life of me see why Mr. Binckley thinks "it may be irreverent to say so." It is all a matter of opinion, and the privilege and ability to entertain and express an opinion on this subject is not solely confined to architects. Surely they, as a class, do not possess a monopoly on good taste, a sense of fitness and of beauty.

F. H. FRANKLAND,
Consulting Engineer.

New York, Nov. 26.

Highway Costs and Traffic

Sir—In your issue of Oct. 21, p. 783, is a table, compiled by J. A. Johnston, containing some valuable data relating to the cost of maintaining several different types of highways in Massachusetts. Such information is always desirable, as maintenance is an important factor in the annual cost of highways, which cost is in turn a part of the total annual cost of transportation. However, in this case, as in many others, the information falls far short of its greatest possible utility because it fails to connect maintenance cost with the factors that produce it, that is, the amount of traffic passing over these highways and the climatic conditions and changes of weather:

Those who are in position to gather information along this line would render a very great service to the engineering profession if they would endeavor to ascertain by actual count, or by estimate, the annual tonnage passing over the roads and then correlate the cost of maintenance with the traffic. In fact it is high time that more attention and effort should be given to the systematic counting of traffic on all our main traveled roads. The observer should seek to determine what part of the wear and deterioration of the pavement is due to traffic and what part to weather and climatic changes.

It should be recognized that wear due to traffic is dependent upon the rate of wear (the amount of wear for one passage of the wheel load) and the number of passages of the wheel load per annum. The rate of wear at any instant is a function of the following factors:

1. Wheel load
2. Speed
3. The kind of tire
4. The amount of previous wear
5. Impact of the unsprung parts
6. The roughness and unevenness of the pavement
7. Resistance of pavement to wear.

Laboratory experiments are needed to determine these functions, but pending such research some advance can be made by frequently observing the roadway and by counting the traffic. On the principle that a half loaf is better than none, any information that can now be collected along the lines suggested will be a big improvement over the present published data. Approximate results are better than no results. For example, traffic counts can easily include, beside the number of vehicles, their size or capacity, which in turn gives a basis for estimating the wheel load. At the same time the kind of tires can be noted, whether solid rubber, penumatic, or steel. In a general way the condition of the pavement can be arrived at by noting the prevalence of holes and their depth, which would give a basis for estimating the amount of impact.

It is admitted that such results would be crude and would be of a provisional nature, but their publication would arouse more interest in the goal to be attained and hasten the time when adequate research work would be undertaken.

ROBERT C. BARNETT,
Economic Engineer.

Kansas City, Mo., Nov. 4.

Bearing-Plate Formulas Disagree

Sir—In general line with recent discussions in *Engineering News-Record* of stray points in structural design, the writer would like to mention one point that seems to need clearing up. It is the method of figuring the thickness of base plates and bearing plates. Recently the writer had occasion to go over the formulas given in handbooks for this purpose and was much surprised to find the difference in results given by the Carnegie "Pocket Companion" and such as Ketchum's "Structural Engineers' Handbook," Kidder's "Architects' and Builders' Pocketbook" and the Bethlehem "Handbook." Investigation showed that the formulas given in the three last named gave the same results, whereas that given in Carnegie gave a much larger result. It seems that the difference lies in the original assumption as to the proper method of figuring the maximum bending moment.

The following figures will show the difference referred to above. Take the case of a bearing plate 12 x 16 in. carrying the end of an I-beam whose flange is 6 in. wide, with end reaction 57,600 lb.; the 16-in. dimension is transverse to the beam, so that the plate projects 5 in. on either side. The Carnegie formula gives $M = \frac{57600 \times 10}{8} = 72{,}000$ in.-lb., requiring a section modulus of 0.375 per lineal inch at 16,000 lb. stress, and the thickness corresponding to this value is 1½ in. The formulas of Ketchum, Kidder and Bethlehem all give a thickness of $1\frac{3}{16}$ in. The table in Carnegie gives 1½ in., in agreement with the formula. It seems as though the Carnegie formula must be in error, and the writer would like to learn the opinions of others.

R. W. BOWMAN.

Alliance, Ohio.
Oct. 23.

[Analysis of the formulas shows that the first considers the bending at the middle of the plate, while the others use the stress in the plate under the edge of the beam flange. Assuming uniformly distributed pressure of the bearing area of beam flange on the plate as well as of the plate on its support, the bending moment in the middle of the plate is greater than that at the edge of the projecting width.—EDITOR.]

HINTS FOR THE CONTRACTOR

Winter Storage of Cement Practicable with Simple Precautions

By Blaine S. Smith
General Sales Manager, Universal Portland Cement Co., Chicago

STORAGE of cement during winter in preparation for the needs of the next season is an effective insurance against delays to work. Unfortunately, many who made preparations for storage last winter could not get the desired shipments, even during the winter months, because the railroads could not furnish sufficient cars. Ordinarily, however, cement manufacturers are able to comply with winter shipping instructions, making it possible for users to stock cement. Storage helps to insure continuous operation during the construction season, when cement shipments may be interrupted by transportation or other conditions. It seems likely that improved transportation conditions this winter will permit manufacturers to ship cement in sufficient quantities for storing.

Next Season's Demand for Cement

Despite the slackening in some lines of business, the demand for cement in the spring of 1921 promises to be such as to warrant the storage of cement this winter. With better labor and transportation conditions road building will probably increase. Appropriations are available for thousands of miles. Relief for the present housing shortage must come. Lessening of the restrictions that have deterred residential building should result in greater activity and an increased demand for materials. The program for public improvements is far behind schedule. The volume of railroad improvements needed is a matter of common knowledge. The demand for building materials in rural districts was not satisfied this year.

Will it pay a contractor to store cement? No one can answer that question as well as the contractor himself, since he is best able to compute what it will cost. By his experience of last year he can determine just what it may mean in dollars and cents to have cement when he needs it. He knows the possibilities for providing storage on his several jobs. He can best judge the necessity for an adequate cement supply and the premium he can afford to pay in the form of storage. Realizing the importance of having cement immediately available when required, several state highway departments have made financial inducements to contractors to store cement during winter months.

In *Engineering News-Record* of June 24, p. 1263, is a report of tests on the effect of storage of cement, made in the Structural Materials Research Laboratory at Chicago. The results confirm the conclusion that cement in storage should be protected not only from water but from free circulation of air. The conclusions drawn from these and other investigations will be of value to builders who contemplate storing cement this winter while the railroads can make shipments. The investigations show that dryness is one of the most essential of the conditions necessary to provide for. If cement is kept in an air-tight container it retains its strength indefinitely. Air always contains some moisture. Cement exposed to free circulation of air will take up moisture and show a loss in strength and slower setting properties according to the degree of exposure.

Tight Warehouses Essential

But cement can be stored so that it will be protected from contact with an amount of moisture appreciably affecting its quality. To secure this protection the warehouse should be made as tight as possible. Drain the vicinity of the warehouse to prevent any accumulation of water. Elevate the floor above ground. Pile cement directly on a dry floor, and stack it against the walls, laying the end bags alternately lengthwise and crosswise, to prevent pressure on the walls and to reduce air circulation.

For long-time storage take extra precautions of which the following are typical: Cover with tarpaulins, straw, burlap or other dry material to reduce air circulation. Leave the cement undisturbed, as "turning" exposes fresh cement to the air. Any "warehouse pack" that does occur can be loosened easily when the cement is removed from storage. After the cement has been stored, inspect the exterior of the warehouse to see that the cement has not caused bulging of the walls in such a manner as to produce cracks. Seal the windows and lock the doors. Then board up the cracks or cover them with tar paper.

A semi-permanent storage warehouse may be constructed as follows: Select a dry site. Dig a level trench for 2 x 8-in. mud-sills. Nail 2 x 4-in. studs on 20-in. spacing to the mud-sills. Nail 1 x 6-in. sheathing on the inside and outside of the studs from the mud-sill to the bottom of the floor joists. Fill the resulting space to the bottom of the joists with well compacted gravel, cinders or dry earth. Place 2 x 6-in. floor joists and complete the fill to the top of the joists. Place two layers of 1-in. rough flooring separated by heavy tar paper. Lap the tar paper 1 ft. on the walls. Sheath the outside of the studs from mud-sill to roof-plate with tight siding. Nail tar paper on the inside of the studs and cover with 1-in. boards and prepared roofing lapped over and under the eaves and nailed to the walls. Fit the doors and windows tight.

Brick Wall Torn Down With Dynamite

REMOVAL of a brick wall 150 ft. long, 22 ft. high and 18 in. thick, and resting upon a concrete foundation extending 18 in. below the ground level, was effected recently by a contractor in Gainesville, Fla., through the use of dynamite. It was desided to take down the wall only to the ground surface, and not to disturb the concrete foundation. In effecting the demolition twenty-six holes were cut into the wall just above the ground, and 2½ lb. of 30 per cent ammonia dynamite were placed in each hole. The charges were connected up in series and fired with electric blasting caps. The wall was cut down clean at the ground level, the work all being done by one man in less than a day, and the total cost, including labor, about $26.

NEWS OF THE WEEK

New York, December 2, 1920

Chief of Engineers Reports on Work of Corps

Large Sums Asked for River and Harbor Projects—For Muscle Shoals Job $10,000,000 Is Needed

An appropriation of $10,000,000 is asked by the Corps of Engineers, U. S. Army, for continuing its work on the Wilson dam at Muscle Shoals, Ala., on the Tennessee River, during the next fiscal year. The total of previous appropriations for this work is $20,351,336.92. Even with continuous and energetic work, it will not be possible to complete the Wilson dam before Jan. 1, 1922. These facts are revealed in the annual report of the Chief of Engineers, for the year ended June 30, 1920, made public last week. As usual, the report is voluminous; its text, exclusive of indices, occupies 2,088 printed pages.

Considerable attention is given in the report to the re-organization of the Corps of Engineers to meet post-war requirements. Both the civilian and military personnel have been reduced greatly. While the National Defense Act authorizes 12,000 enlisted men for the corps, its actual strength, at the end of the fiscal year, was 4,652 men.

The report shows that a large amount of topographic work was done by the Corps during the year, but that the maps of the territory surveyed have not been reproduced, due to lack of funds.

Since the armistice sales of surplus engineer material have netted over $110,000,000. The average return was 84 per cent of the cost price. On orders valued originally at $78,068,539.97, adjustments have been made by the Engineer Claims Board for $7,810,225.80. Included in the settlement was finished material valued at $5,786,641.35, making the cost of settlement $2,003,484.45.

River and Harbor Demands

The report reveals for the first time that the Chief of Engineers has asked Congress for $57,206,715 to be carried by the River and Harbor bill; $10,982,950 for works under continuing contracts, to be carried by the Sundry Civil bill. This is in addition to the $10,000,000 asked for the nitrate plant development at Muscle Shoals and $18,000,000 for the expenses of the California Debris Commission.

During the year the Corps expended $47,187,541.83 of government funds on river and harbor works, in addition to $2,255,321.95 contributed by local interests.

For the continuance of construction

(*Continued on p. 1108*)

Opposition Candidates for Am. Soc. C. E. Offices Named

A full ticket of candidates for office in the American Society of Civil Engineers, in opposition to the one selected by the Nominating Committee, has been established by "declaration," in accordance with Section 4 of Article 7 of the constitution, which authorizes additional nominations filed before Dec. 1, endorsed with the signatures of twenty-five corporate members and accompanied by signed acceptances from the nominees. The new slate is as follows:

President—J. Waldo Smith, chief engineer, Board of Water Supply of the City of New York.

Vice-Presidents—Allen Hazen, consulting engineer, New York City; and Frank G. Jonah, chief engineer, Frisco Lines, St. Louis, Mo.

Treasurer—Arthur S. Tuttle, deputy chief engineer, Board of Estimate and Apportionment, New York City.

Directors—District 1, John P. Hogan, chief of engineering staff, state water-power investigations, New York City, and Robert S. Parsons, general manager, Erie R.R., New York. District 4, Harry A. Lane, chief engineer, Baltimore & Ohio R.R., Baltimore Md. District 9, Alexander Maitland, Jr., president, Kansas City Bridge Co., Kansas City, Mo. District 10, F. T. Darrow, assistant chief engineer, C. B. & Q. R.R., Lincoln, Neb. District 11, Richard D. Parker, chief engineer, State Railroad Commission, Austin, Tex.

The Nominating Committee's selection of candidates, as published in *Engineering News-Record*, Oct. 7, p. 723, was as follows:

President—George S. Webster, Philadelphia.

Vice-Presidents—Andrew M. Hunt, New York, and Edward E. Wall, St. Louis.

Treasurer—Otis E. Hovey, New York.

Directors—John P. Hogan and Ira W. McConnell, New York (District 1); Richard L. Humphrey, Philadelphia (District 4); Baxter L. Brown, St. Louis (District 9); Frank T. Darrow, Lincoln, Neb. (District 10); George G. Anderson, Los Angeles (District 11).

City Debt Limit Raised in Larger Cities of Missouri

The constitutional amendment permitting Missouri cities of 100,000 and over to increase their bond limit from 5 to 10 per cent of their assessed valuation, noted in our issue of Nov. 11, p. 961, as publicly carried was actually adopted by a vote of 368,651 to 329,938.

McCormick Drafts New Public Works Bill

Measure Does Not Conflict With Jones-Reavis Bill, Says M. C. Leighton, of Engineering Council

A preliminary draft of Senator Medill McCormick's bill for the reorganization of the government departments was made public last week. Senator McCormick has had in mind the preparation of this measure ever since he introduced his original budget measure in 1917. The latter, amended to meet the President's objections as expressed in his veto, is pending on the Senate calendar now, having been passed by the House last June.

The McCormick reorganization bill abolishes the Interior Department, creates in its stead the two new department's of Public Works and Public Welfare, divests the War and Treasury departments of functions not germane to the national defense or the national finances, and in general is designed to co-ordinate existing agencies which now are scattered irrelevantly and wastefully throughout the whole government organization. The bill will be introduced on the opening day of the approaching session of Congress, although action on it probably will be deferred until after Senator Harding's inauguration.

The McCormick bill as drawn brings together in the Department of Public Works all important engineering and building services of the government, now scattered among various departments, and authorizes the Secretary of Public Works to make such changes in the organization of these existing agencies as will increase their efficiency and lead to economy in expenditures. Army officers now detailed on engineering works would continue to hold their present assignments for three months after the measure goes into operation in order to give the Secretary of Public Works sufficient time to make an appropriate consolidation or rearrangement of these agencies without interrupting important work.

After receiving from Senator McCormick's office the summary of his proposed bill, *Engineering News-Record* requested from Marshall O. Leighton, Engineering Council's representative at Washington, a statement covering the relation of that measure to the Jones-Reavis bill. The McCormick bill, says Mr. Leighton, is not in conflict with the Jones-Reavis bill. The provision in the McCormick bill for a public welfare department may possibly delay the national department of public work, but Mr. Leighton believes that all supporters of the Jones-Reavis bill may

cordially support the McCormick bill.

The bureaus, offices and branches of service included in the Department of Public Works, as proposed by Senator McCormick, are:

(a) From Department of the Interior—
General Land Office
Geological Survey
Bureau of Mines
Reclamation Service
National Park Service
Division of Capitol Buildings and Grounds
Alaskan Engineering Commission
(b) From Department of the Treasury—
Office of Supervising Architect
(c) From Department of Agriculture—
Bureau of Public Roads
Forest Service
(d) Office of Superintendent of State, War, and Navy Department Buildings
(e) Rock Creek and Potomac Parkway Commission (abolished and its functions transferred to Department of Public Works)
(f) Commission of Fine Arts
(g) From the Department of War—
Board of Engineers for Rivers and Harbors
Board of Engineers of New York City
Office of Supervisor of the Harbor of New York
United States Engineer Offices
Mississippi River Commission
California Debris Commission
Board of Road Commissioners for Alaska
Office of Public Buildings and Grounds and Washington Monument
(h) Federal Power Commission (abolished and its functions transferred to Department of Public Works)

I. C. C. Clears Up Definition of Technical Engineer

Last month the Interstate Commerce Commission issued regulations placing engineers in the subordinate official class as engineers of mechanics. The American Association of Engineers, through a committee headed by George W. Hand, assistant to the president, Chicago & Northwestern Ry., protested Nov. 1 that the term was not clear as to whether it included mechanical and electrical engineers. The I. C. C. has now issued new regulations designating professional engineers as technical engineers to include civil, mechanical, electrical and other technical engineers inferior in rank to engineers of maintenance of way, chief engineers, division engineers and other technical engineers. The opinion is expressed that instrumentmen, rodmen, chainmen, designers, draftsmen, computers, tracers, chemists and others in similar engineering or technical work are not "officials of the carriers."

Chief of Engineers' Report

(*Continued from p. 1107*)

and maintenance of Alaskan roads, the Chief of Engineers asks for $955,000.

Expenditures smaller than those of former years will be made by the Corps on Panama fortifications, due to the fact that most of the defensive works on the Isthmus have been completed. During the next fiscal year, however, the chief of Engineers asks for $425,000 for the construction of seacoast batteries and $405,000 for the construction of sea walls. The remaining expenditures are mainly for maintenance work and for supplies.

Philadelphia-Camden Bridge Study Makes Progress

Organization of a technical staff for the engineering investigation of the proposed bridge over the Delaware River between Philadelphia and Camden was advanced at a meeting of the board held last week with the appointment of the following: Leon S. Moisseiff, consulting designing engineer, at $1,000 per month; Clement E. Chase, principal assistant engineer, at $500 per month; Ralph B. Liggett, chief clerk, at $200 per month; John Briggs, surveyor and draftsman, at $225 per month. These appointments were approved by the Interstate Bridge Commission on Nov. 19, and at the same time the commission approved the budget proposed by the board, which contemplates the expenditure of not more than $100,000 on the study of site type and estimated cost of the bridge, of which some $50,000 is the compensation of the three members of the board of engineers and $50,000 is to be devoted to fees of architectural and engineering consultants, salaries of staff, cost of test borings and other expenses.

Mr. Moisseiff was designing engineer for the New York Department of Bridges during the construction of the Williamsburg, Manhattan and Queensborough bridges, and has been in private practice as consulting engineer since 1915. Mr. Chase has been with R. Modjeski for the past ten years, being now in charge of the latter's New York office.

Specifications and contract forms for the test borings at the three bridge sites to be studied were submitted by the board of engineers and approved by the commission; the work will probably be advertised shortly. It is contemplated to put down but one test hole at the location of each pier and anchorage; this is considered to be sufficient as the foundation conditions are not expected to be a controlling factor in determining the site, being far outweighed by considerations of traffic needs and possibilities and the cost of land. The borings are to be extended into rock, however, so that the results obtained will be wholly dependable. They believe this to be particularly important because present knowledge of subsoil conditions under the Delaware River is meager, aside from the negative testimony afforded by artesian wells drilled on land near the river without striking rock.

The board of engineers is composed of Ralph Modjeski, George S. Webster, and Laurence A. Ball. The joint Delaware River Bridge Commission (of the States of Pennsylvania and New Jersey) is under the chairmanship of Governor Sproul, of Pennsylvania.

Reserve Needs Engineer Officers

The examining board for the engineer section of the Officers' Reserve Corps is now functioning and is anxious to receive applications of former engineer officers.

All Except Harbor Bonds Carried At Houston, Tex.

Bond issues totalling $875,000 for city work at Houston, Tex., were carried Nov. 2 as follows: bridges, $425,000; street improvements, $200,000; sewers, $100,000; schools, $150,000. A bond issue for harbor improvements was defeated, largely because a proposition for the purchase of 600 acres of land for wharf and industrial sites proved unpopular and had its effect in defeating all items for harbor work.

Boards of Engineering Examiners Form Council

Seven state boards of engineering examiners were represented at an organization meeting Nov. 8 and 9 in Chicago at which the National Council of State Boards of Engineering Examiners was formed. The purpose stated in the constitution is "to examine the state laws providing for registration of engineers and the custom and rule of procedure of the different boards in the examination of applicants with suggestions and recommendations for uniformity of practice so far as the same can legally be done by the different state boards, and to provide for reciprocal relations between the state boards for granting registration licenses to applicants from other states on equal terms of examination."

K. C. Kastberg, secretary of the Iowa board and city engineer of Des Moines, sent out a call for the meeting. He explained that there should be an organized and systematized method of procedure to be followed in the interstate registration and a plan for facilitating the procurement of license or registration. Informally under Seth Dean (Iowa) as chairman and Mr. Kastberg as secretary these matters and the administration of the various laws were discussed in detail by representatives from Iowa, Illinois, Florida, Louisiana, South Dakota and Michigan.

The following resolutions indicate the unanimity of opinion on reciprocity; (1) That where a qualified engineer obtains a contract he be permitted to proceed after filing an application and pledging himself to appear for examination at the next board meeting; (2) that efforts be made by the several states to standardize the examinations; (3) that members of the various boards be granted reciprocity license or registration without examination.

Much of the time was taken up in an explanation and discussion by T. L. Condron of the provisions in the proposed draft of a uniform law recently approved by Engineering Council.

The officers elected were: President, Marcel Garsaud, New Orleans; vice-president, C. S. Hammatt, Jacksonville, Fla., and secretary-treasurer, Alvin Le Van, Des Moines, Iowa. The next meeting will be held Oct. 3, 1921, in St. Louis.

Highway Estimates To Be Made Known After Receipt of Bids

The state highway commission of Indiana has adopted the policy of not making public its engineering department's cost estimates on jobs until after it has opened bids on the jobs. The motion to adopt such a policy was unanimously agreed on by the commission at a recent meeting. Heretofore the estimates have been accessible to the public before bids were opened. The theory back of the new policy is said to be that if contractors do not know the estimates before they bid, they will be unable to bid so closely to the estimates, and that by bidding "in the dark" the contractors may bid further below the estimates than they would if they knew the estimates in advance.

City Managers' Association Meets at Cincinnati

The seventh annual meeting of the City Managers' Association, held at Cincinnati, Ohio, Nov. 15-17, was by far the largest and most enthusiaistic meeting yet held. Approximately 100 delegates registered, half of the number being city managers. About half of the 200 city managers in the country have had engineering training.

"A Model Paving Program for a City of Twenty Thousand," was discussed by technical experts of the Portland Cement Association, the National Paving Brick Manufacturers Association, the Barber Asphalt Paving Co., and the Barrett Co. Each speaker presented his version of the program in a 15-min. paper. General discussion followed. Other topics were: "Practical Budget Procedure," a paper by C. E. Rightor, of the Detroit Bureau of Governmental Research; "Setting Up a City Plan Program," by Morris Knowles, of Pittsburgh; "Building a Fundamental First Step in City Planning," by W. J. Donald, director American City Consultants, New York; "City Planning Achievements in the United States," by George B. Ford, city planning consultant, New York City; "Making City-Owned Utilities Pay," by J. W. Greer, city manager of Tallahassee, Fla., and H. L. Woolhiser, village manager, Winnetka, Ill.; "The Relation of Motor Trucks to City Business," by Raymond W. Parlin, International Motor Co., New York.

The proceedings of the convention will be published in the Seventh Year Book of the City Managers' Association.

The new officers elected at the meeting were: President, A. W. D. Hall, city manager, Jackson, Mich.; first vice-president, George M. Zimmerman, city manager, Sandusky, Ohio; second vice-president, Edwin J. Fort, city manager, Niagara Falls, N. Y.; third vice-president, Wilder M. Rich, city manager, Goldsboro, N. C. Harrison G. Otis, Tribune Building, New York City, was re-elected executive secretary.

$25,000,000 Teredo Damage Studied by Committee

Interests Participating in Work at San Francisco Include Railroads, Ship Owners, Army and Navy

A survey of the damage caused by marine borers in the San Francisco bay region and an investigation to determine the best means of combating them have been undertaken by the Forest Products Laboratory of the U. S. Forest Service in co-operation with the San Francisco Bay marine piling committee of the American Wood Preservers Association. This work was begun after the rapid and very great increase in borer damage to waterfront structures during the past two or three years in the upper bay, as described in *Engineering News-Record*, May 20, p. 1000.

In the upper bay, by reason of past immunity, most of the waterfront structures had been built of untreated piling. This afforded a clear field for the teredos, whose attack was so rapid and severe that structures valued at many millions of dollars were destroyed. According to a recent statement by the marine piling committee above referred to, "Docks have been failing and frequently dropping into the bay with accompanying menace to the other structures, during the entire year past. The damage, which has been estimated by the committee at $25,000,000 up to the present time, bids fair to greatly exceed that sum in the near future."

Many Interests Represented

This committee consists of engineering representatives of the state board of harbor commissioners, the principal railroads, oil companies and shipping interests having waterfront structures in the bay, who are financing the investigation, and representatives of the Army, Navy, U. S. Engineer Corps, immigration commission and lighthouse board, and the University of California.

F. D. Mattos, superintendent of creosoting plants for the Southern Pacific Co., is chairman of the committee. Prof. C. A. Kofoid, marine biologist, is studying the biological aspects of the problem as representative of the University of California. The Forest Products Laboratory is represented by Geo. M. Hunt, chief of the section of wood preservation, and T. G. Townsend, engineer in forest products, who are conducting the survey. The executive officer of the committee, to whom communications may be addressed, is C. L. Hill, chief of the office of forest products, U. S. Forest Service, Ferry Bldg., San Francisco.

This study, it is announced, will be the first unit of a nationwide investigation under the auspices of the United States Forest Service and co-operating associations of wood preservers, lumbermen, railroads and many other industries having interests at stake, which will cover the entire coastal waters of the continental United States. Its ultimate object will be to find the best means of combating these attacks.

Chicago Conference on Education and Employment

That personal work is necessary in engineering schools and that the best teachers should be placed in charge of the more elementary work were definite opinions expressed in two resolutions adopted at a conference on employment and education, held in Chicago on Nov. 12, under the direction of the American Association of Engineers. Both resolutions were introduced by Dean E. J. McCaustland, University of Missouri. Courses in management at technical schools were advocated by R. O. Kramer, manager of the mechanical department of Montgomery, Ward & Co., his idea being to prepare engineers for executive positions. On the other hand, Dean A. A. Potter, Purdue University, held that although to a certain extent there is a demand for a specialized product the aim of the schools is to give a broad fundamental training which will serve to adapt the graduate engineer to any field of work.

A student entering college should be interviewed by a vocational adviser in order to give him the right start, according to J. H. Libberton, manager of the service bureau of the Universal Portland Cement Co., who also advised that men of the best talent should be secured as teachers and encouraged to engage in private practice. Methods of helping the undergraduate engineer to decide what line of work to undertake were explained by A. B. Crawford, director of the bureau of appointments at Yale University. In regard to the army schools, A. B. McDaniel, development specialist for the U. S. Army, explained the methods of training the soldier student to plan and execute work in some one of about a hundred vocations.

The Chicago conference showed, on the whole, greater unanimity of opinion as to employment than as to education, but it showed also the importance of joint consideration of the two subjects.

General Contractors Indorse Lockwood Inquiry

At a meeting of the executive board of the Associated General Contractors of America held recently in Washington, D. C., resolutions were adopted unanimously endorsing the action of the Lockwood Joint Legislative Committee which is investigating housing conditions in New York City. Plans were also laid for securing the co-operation of the United States Chamber of Commerce and other employers' associations in urging the Lockwood Committee to "pursue its investigations without fear or favor to the end that all guilty may be exposed and punished and that justice thereby be done to those who are condemning the purchase of immunity from labor troubles by the corruption of labor officials, desire an honorable settlement of the labor problems based on fair dealings."

Architects' Examining Boards Have Council

A copyright for the word "architect," a standard examination, and a feeling that joint registration laws for engineers and architects is undesirable, were points of interest to engineers in the meeting at St. Louis, Nov. 18 and 19, of the National Council of Architectural Registration Boards. The conference was called to consider the present status of registration and the experience obtained in giving the various laws effect, and to bring about cooperation.

The trend of the meeting was toward a copyright of the word "architect" on the principle that the passing on an individual by a board is a notice to the public that the holder is competent to practice architecture, but that competency must then educate the public. There was a strong tendency, led by Illinois and New Jersey, not to support Article 18 of the proposed model law of the American Institute of Architects which, while fully protecting the word "architect," would not protect engineers and other from doing similar work providing they use the correct appellation. A motion to the effect that Article 18 reflects the sense of the meeting was laid on the table.

By resolution the issuance of certificates to alien engineers was approved and so was another resolution "that a joint registration law for architects and engineers is undesirable."

Reciprocity between states has been found difficult under existing laws because of the lack of uniformity in requirements but a way out seemed likely in the latitude most of the laws gave the examining boards in conducting examinations. It was the general opinion that a standard examination could be devised by the Council.

Fail To Agree on Waterfront Viaduct at Toronto

A recent conference on the plans for a railway viaduct along the waterfront at Toronto, Ont., failed to arrive at any conclusion owing to the opposing views of the city officials, the railways and the harbor commission. Before the war the railways had agreed to build a six-track elevated line, as required by the Railway Board, but now they wish to have the work postponed for ten years, laying tracks at the present level into the new union station and providing subways and temporary bridges at important streets intersected by the railway line. The new station building is practically finished, and two floors are occupied for railway offices. The city is insistent that the viaduct should be commenced at once. A postponement was granted to enable the railway engineers to consider the alternative plans of procedure, after which there will be another conference of representatives of all interests concerned.

Railway Fire Protection Meeting

So much interest was shown in a report on fire hazards and fire protection in railway shops and roundhouses, presented at the recent annual meeting of the Railway Fire Protection Association, that the matter was again submitted to a committee for further elaboration. A brief report on the use of small gasoline tractors in freight houses and piers gave some rules for care and handling, but this report was incomplete and was referred back to the committee. These tractors do not appear to be a serious risk and although a proposition was made to exclude them from freight houses this was defeated after an explanation that shippers' motor trucks must be admitted. The fire risks incidental to industries served by railways were reviewed in a paper by W. F. Hickey, who outlined various chances of fire in plants entered by steam and electric locomotives. Carelessness in handling and storing refuse is a large cause of fire, and may be reduced by persistent instruction and inspection, but this should be by personal methods rather than by merely issuing circulars and bulletins. In regard to oil fires, a resolution was passed approving any extinguishers approved for this purpose by the Underwriters Association. W. F. Hickey was elected president; secretary, R. R. Hackett, Baltimore & Ohio R.R., Baltimore, Md.

Lime Association Appoints Department Managers

Laurance H. Hart, the newly appointed manager of the construction department of the National Lime Association, and Dr. E. Holmes, newly appointed manager of the chemistry department, are to act as consultants on any phase of the use of lime. Mr. Hart will handle the use of lime in building operations from lime used in brick work to stucco and concrete, and Dr. Holmes' services are available to anyone interested in the chemical use of lime.

Mr. Hart went to the National Lime Association from the Lakewood Engineering Co., in which organization he was employed as construction sales engineer in Michigan. Previous to that time, he was with the Hunkin-Conkey Construction Co., of Cleveland, as manager of the western New York office; and the Lupfer & Remick consulting and contracting engineering firm at Buffalo.

Dr. Holmes was at one time research engineer for the National Carbon Co., Cleveland. His industrial experience covered practically all the departments of a manufacturing establishment, but particularly has he been engaged in technical control of factory production, development of new products and improvement of old products, the building and operation of semi-factory plants, consulting work with departmental heads, technical research and the preparation of technical literature.

New California Road Contracts Ready by February First

The earliest date on which California highway contracts will be awarded under the new flexible interest plan will probably be Feb. 1, according to a recent announcement by the California Highway Commission. This plan, which was approved at the recent election and described in *Engineering News-Record* Nov. 11, 1920, p. 962, will be acted upon at once, but the legal requirements are such that some delay is unavoidable.

The amendment does not become operative until five days after certification by the secretary of state who will not be able to effect a complete and official canvass of the Nov. 2 vote much before Dec. 1. Thereafter the new state highway finance board must meet, fix a prevailing interest rate and offer for sale such an amount of bonds as is needed to meet existing obligations and provide for new work. This operation, according to the commission's announcement, will consume not less than sixty days as the bond sale advertisement will take thirty days and printing and signing bonds will take an equal amount of time.

Brindell Indicted for Attempted Extortion as Inquiry Result

Robert P. Brindell, head of the Building Trades Council of New York City, who has been under fire from the Lockwood Joint Legislative Committee investigating the housing situation, has been indicted by the November additional grand jury of the city and county of New York on three counts of attempted extortion. His arraignment before Judge Mulqueen, of General Sessions, resulted in a bail of $100,000 being fixed, a sum which was secured by Brindell. The specific charges against Brindell concern his alleged attempted extortion from Jacob Fradus, a wrecking contractor, as insurance against strikes. It is the assertion of the special assistant district attorney who made a plea for a bail of $100,000 being fixed, that Brindell's alleged extortions will aggregate $1,000,000.

New York Highway Transport Show in January

The first New York Highway Transportation Show will be held in that city Jan. 3-8, 1921, under the auspices of the Motor Truck Association of America, 144 West 65th St., New York City. The exhibit will occupy the 12th Regiment Armory, Columbus Ave. and 62d St. The exhibit will include trucks, trailers and accessories, educational exhibits, a model terminal, and model traffic control. It is planned to include in the program addresses on highway transport problems. The program has been divided into Army Day, Motor Accident Prevention Day, Highway Transportation Day, Farmers' Day and Motor Truck Association Day.

Wall of Store Slides Into Nearby Excavation

Collapse of the rear wall of a department store building in Topeka on Nov. 6, in which fortunately no one was injured though large property loss was caused to the store, was brought about by weakening of a lateral support of the wall foundation by excavation for an extension at the rear of the store. This excavation had approached within 8 or 10 ft. of the rear wall, a distance which the contractor regarded as safe. The wall foundation was rendered less stable than under ordinary circumstances, it is thought, by the existence of a former well, long ago filled with earth, close to the foot of the wall, about at the middle of its length. Some outward leakage of drainage water from the building may have contributed to the failure. Longitudinal girders supporting joists of floor and roof of the building rested on the rear wall near its middle, bringing a concentrated load to bear on the foundation at this point. With the failure of the wall these girders and the joists carried by them sagged, rendering part of the structure of the store unsafe.

Cracking noises suggesting movement of the wall were heard by a watchman during the night, but the wall did not fail until eight in the morning, after having given noticeable warnings of approaching failure half an hour earlier.

South Bend Postpones Water-Works for Lower Prices

Following the advice of W. A. Artingstall, city engineer of South Bend, Ind., the water-works department has decided not to award contracts for work recently advertised but to postpone all improvements until next spring, expecting a reduction of approximately 25 per cent in the cost of materials and labor. The present plans called for an expenditure of $150,000.

One Concrete Ship Sold; Three Wrecked

One of the 7,500-ton reinforced concrete tankers built for the United States Shipping Board has been sold and several of the smaller boats have been under lease and the larger ones are for sale. The vessel sold is the *Latham* which was built at Mobile and it has been bought by the American Fuel Oil Transportation Co. for $700,000. Of the other ships built the *Polias* was wrecked last winter off Penobscot Bay in Maine, and a contract has been entered into with Aëronautical Equipment, Inc., of New York City, on a "No cure, no pay" basis to salvage the ship. It is reported that the salvage operations are proceeding successfully. The *Selma*, a 7,500-ton ship, built at Mobile, ran on the breakwater at Tampico early this summer. It has been dragged off and towed up to Galveston for repairs, which are now under way. The *Cape Fear*, as reported on another page of this issue, was sunk on Oct. 29 in Narragansett Bay.

By the original contract for concrete ships by the Shipping Board there have been completed six 7,500-ton ships, three 3,500-ton ships, and two 3,000-ton ships. Contracts for three of the original nine 7,500-ton ships were canceled and the ships left half-completed on the ways.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

The Engineers' Club of Philadelphia, at its weekly luncheon meeting, Nov. 23, was addressed by E. J. Mehren, editor of *Engineering News-Record*, on "An Engineer's Observations in Europe."

The Philadelphia Post, Society of American Military Engineers, held a meeting at the Engineers' Club of Philadelphia recently at which time the constitution and by-laws of the local post were adopted. The following officers were elected to hold office until Jan., 1922: Col. W. B. Ladue, commander; Major Marshall R. Pugh, vice-commander; Major H. W. Goddard, adjutant; Capt. J. C. Hinton, finance officer. Staff officers elected for two years are: Lieut.-Col. Henry S. Spackman, Major Thos. W. Battin, and Capt. Clarence Roberts; and for one year, Capt. R. W. Robinson, Lieut. Robert L. Harding. Regular meetings are to be held the fourth Thursday of each month during the winter.

The Association of Chinese and American Engineers, formed with the sanction of the Chinese Government and supported by the highest officials of the Government of China, by the American Minister to China and prominent American engineers in that country, desires to exchange the English edition of its journal with the publications of other engineering societies throughout the world, and particularly with American engineering societies. The secretary of the association is P. Y. Tsai, assistant engineer, Chuchow-Chincow Ry., Peking, China. The chairman of the publication committee is Murray Sullivan, acting chief engineer of the railway named.

The Detroit Engineering Society was addressed Nov. 19 by Lieut.-Col. T. A. Leisen, civil engineer of the Board of Water Commissioners on "The Detroit Filtration Plant."

The Montana Irrigation and Drainage Institute, at its meeting held in Billings, Nov. 10-11, elected G. C. Sanford, Great Falls, president and E. H. Murdock, Bozeman, secretary-treasurer. The Institute approved a committee draft for a state irrigation code of 14,000 words to be submitted to the legislature in January.

The Iowa Section, American Waterworks Association at its sixth annual meeting Nov. 5 and 6, elected the following officers. Chairman, Francis D. H. Lawlor; vice-chairman, J. Chris Jensen; directors, R. C. McDonnell and H. V. Knouse; secretary-treasurer, Jack J. Hinman, Jr., Iowa City.

An Affiliation of nearly all the engineering societies of Baltimore with the Engineers' Club of that city, and the establishment of headquarters of the enlarged Engineers' Club on the fifth floor of the Merchants and Manufacturers' Association Building, was decided upon Nov. 4 at a meeting of Baltimore engineers in celebration of the fortieth anniversary of the founding of the American Society of Mechanical Engineers. The Baltimore branch of the American Society of Mechanical Engineers decided after the meeting to join with the Engineers' Club. The American Association of Engineers, at a meeting Nov. 5, also voted to cooperate with the other engineering bodies. In all, about ten engineering bodies have combined in the new organization.

The New England Waterworks Association, at its meeting Dec. 8, will be addressed by M. Betant, engineer director of water supply service, City of Geneva, on "The Water Supply of Geneva, Switzerland." There will be a general discussion on the cleaning and painting of standpipes, opened by Charles W. Sherman of Metcalf & Eddy, consulting engineers, followed by Prof. Harold K. Barrows, consulting engineer.

PERSONAL NOTES

LEON S. MOISSEIFF has been appointed consulting designing engineer on the technical staff for the engineering investigation of the proposed bridge over the Delaware River, between Philadelphia and Camden. Mr. Moisseiff was designing engineer for the New York Department of Bridges during the construction of the Williamsburgh, Manhattan and Queensboro bridges and has been in private practice as consulting engineer since 1915.

P. G. BRUTON, formerly chief of the material sales section, Material Disposal & Salvage Division, Air Service, at Buffalo, has accepted a commission in the Corps of Engineers, U. S. A., and is assigned to the 6th Engineers, Camp Pike, Ark.

EMILE G. PERROT, formerly of the firm of Ballinger & Perrot, architects and engineers, announces the opening of offices in the Woolworth Building, New York, and the Parkway Building, Philadelphia, Pa. Mr. Perrot has been associated as architect and engineer with the erection of industrial structures for twenty-five years and he announces the continuation of his professional activities under his personal direction in the designing and construction of industrial plants and institutions.

H. LEE WILSON, assistant city engineer, Johnstown, Pa., has been appointed city engineer to succeed Jackson R. Crissey, resigned.

BRUCE L. MELOY, formerly field engineer, Johnstown, Pa., has been appointed assistant city engineer.

DR. HERMANN M. BIGGS, health commissioner of New York State, has temporarily assumed the duties of general medical director, League of Red Cross Societies, Geneva, Switzerland, in place of Dr. Richard P. Strong, the latter having resigned to resume his position of professor of tropical medicine at Harvard University. Ad interim, Colonel F. F. Langley, who succeeds Prof. Geo. C. Whipple as chief of the league's department of sanitation, was medical director.

W. C. WEST, formerly resident engineer on work on the Dixie Highway north of Toledo, Ohio, is now assistant district engineer stationed at Saginaw, Mich.

JOSEPH T. KIERNAN has resigned his position as assistant engineer with Hill & Ferguson, consulting engineers, New York City, to take the position of office engineer in the chief engineer's office of the Interstate Railroad at Norton, Va.

J. B. DAWSON, recently division engineer in District 9, Kentucky State Highway Department, has been appointed maintenance engineer.

C. F. FOSTER, assistant district engineer of bridges, central and southeastern districts, Michigan State Highway Department, has been appointed district engineer for the west central portion of the state with headquarters at Grand Rapids.

G. N. PRENTISS, formerly chief chemist Chicago, Milwaukee & St. Paul R.R., has been promoted to engineer of tests with headquarters at Milwaukee.

W. H. WILSON, formerly assistant engineer Southern Ry., at Chattanooga, Tenn., has accepted a position as assistant engineer in the construction department, Southern Ry., Washington, D. C.

E. G. LANE, engineer maintenance of way, Western lines, Baltimore & Ohio R.R., with headquarters at Cincinnati, has been appointed engineer maintenance of way, Eastern lines, with headquarters at Baltimore, Md.

W. A. KENNON, division engineer, Missouri Pacific R.R. at St. Louis, Mo., has been transferred to a similar position with headquarters at Osawatomie, Kan.

L. WINSHIP, formerly assistant engineer, Missouri Pacific R.R. at St. Louis, Mo., has been appointed division engineer with headquarters at Nevada, Mo.

J. R. NAGLE, formerly division engineer, Missouri Pacific R.R. at Nevada, Mo., has been transferred to St. Louis, Mo., as division engineer.

E. P. GUTELIUS, vice-president and general manager, Delaware & Hudson Railway, has been appointed to act in an advisory capacity to the royal commission which is investigating the radial railway projects of the Ontario Hydro-Electric Power Commission, Toronto, Ont., Canada.

S. M. BAILEY, formerly resident engineer for the Department of Public Roads, Kentucky, has been appointed resident engineer, North Carolina Highway Commission in charge of gravel road construction on Federal-Aid Projects 69 and 115 and Federal-Aid Survey 78-D in western North Carolina.

OBITUARY

COL. THOMAS W. SYMONS, Corps of Engineers, U. S. A., retired, died Nov. 23, at Washington, D. C. He was born in 1849 and was graduated from the U. S. Military Academy, 1874. His first assignment was as an engineer on the Wheeler Survey under the War Department (1876-1879). From 1879 to 1882, engineer of the Military Department of the Columbia; 1882-1883, on Mississippi River improvement; 1883, in charge of reconnaissance of natural boundary line between United States and Mexico; 1883-1886, superintending engineer, Washington aqueduct and works for improving the water supply of the national capitol; 1886-1889, assistant to engineer commissioner and in charge of engineering work in the District of Columbia; 1889, in charge of various works of river and harbor improvements in Oregon, Washington and Idaho. In 1901 he was appointed by Governor Theodore Roosevelt as director and member of the executive committee of the Pan-American Exposition at Buffalo, N. Y. From 1903 to 1904 he was in charge of public buildings and grounds and military aid to President Roosevelt, Washington, D. C. He was a member of the advisory board of consulting engineers on New York State canal improvements for which the state appropriated $101,000,000. In 1908 he was commissioned colonel of the Corps of Engineers, U. S. A. and, after thirty years of service with the government, he retired July 28, 1908, at his own request.

HERBERT M. WILSON, general manager, Associated Insurance Companies, died Nov. 25, at Hartford, Conn. He was born in Glasgow, Scotland, Aug. 23, 1860. He was graduated with the degree C. E. from the Columbia University School of Mines, 1881. From 1881 to 1882 he was on the U. S. Geological Survey as topographer; 1882-1888, irrigation engineer; 1892-1906, chief engineer technologic branch; 1907-1909, engineer in charge, U. S. Bureau of Mines; 1910-1914, director department of inspection and safety, The Associated Insurance Company, and from 1915 he was general manager of this company. He has lectured extensively on irrigation, fuel testing, smoke abatement, fireproof building construction, etc. He was the author of "Manual of Irrigation Engineering, Topographic Surveying," and numerous magazine articles on the above subjects.

EDWARD F. LEIDL, chief engineer of sewers, Milwaukee, Wis., since 1914, died Nov. 21. He was 46 years old. He entered the employ of the city as a chainman in 1894, continuing in the municipal service until his death. He was appointed chief engineer, department of sewers, in 1914.

WALTER D. MOODY, managing director of the Chicago Plan Commission, died at Chicago, Nov. 21. He was the author of the "Manual on City Planning" and "What of the City?"

RICHARD J. GOODBODY, formerly superintendent of streets, San Diego, Cal., died in that city Nov. 20. He was 58 years old. He constructed the irrigation distribution system for the Southern California Mountain Water Co., San Diego. He was also for some years in the general cement contracting business and supervised a large amount of county highway construction.

ARTHUR S. GOODEVE, member of the Board of Railway Comissioners, Ottawa, Canada, died Nov. 22 at Toronto. He was born in Guelph, Ont., Canada, Dec. 15, 1860. He was a graduate of the Ontario College of Pharmacy, Toronto. In 1903 he was appointed provincial secretary of the first Conservative Government—became a member of Federal House for Kootenay district in 1908. In 1912 he was appointed to the Board of Railway Commissioners.

J. G. SCHILLINGER, chief engineer, Rutland R.R., died Nov. 12 at Burlington, Vt. He was graduated from Cornell University, 1892. He was at one time in the service of the New York Central R.R. as division engineer.